SEPTEMBER 1959

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ILLUMINATING ENGINEERING

Journal of the
ILLUMINATING ENGINEERING SOCIETY

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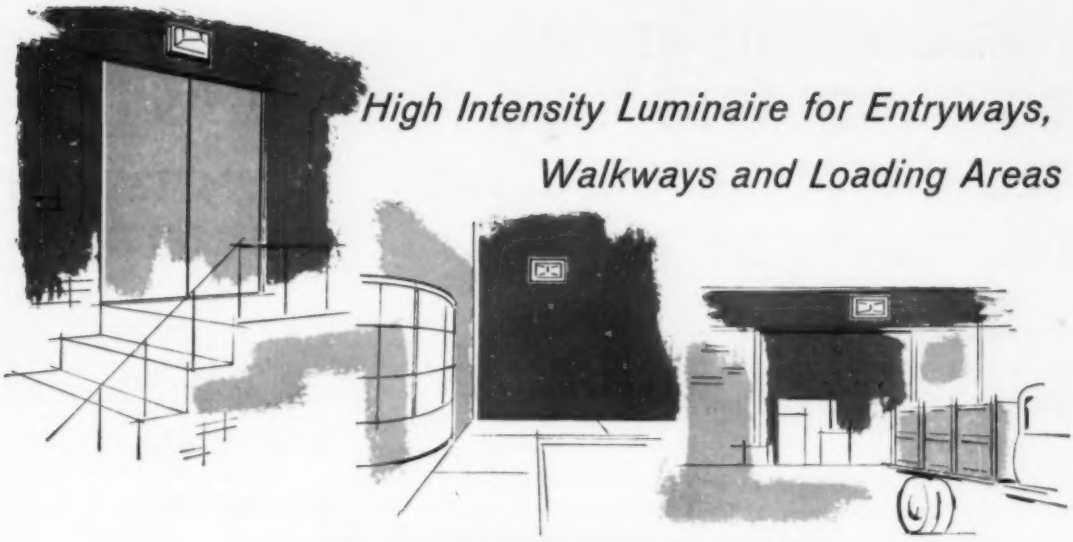

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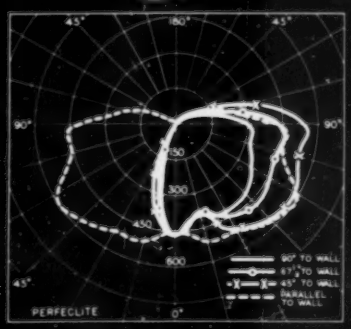

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

September 1959

Vol. LIV, No. 9

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Contents

537 IES National Technical Conference — Editorial

538 The President's Report — George J. Taylor

544 The Vice-President's Report — Joe B. Browder

548 Light Sources — Conference Paper Abstracts

565 Photometry — Conference Paper Abstracts

569 Calculations and Research — Conference Paper Abstracts

574 Lighting Applications — Conference Paper Abstracts

585 Roadway Lighting — Conference Paper Abstracts

593 IES Lighting Data Sheet — Series XXIV
High Bay Industrial Lighting (7-19)

594 New Designations for Mercury Lamps — William S. Till and Mario Pisciotta

597 Recommended Practice for Marine Lighting

608 IES Lighting Data Sheet — Series XXIV
Lighting a Building's Sign (23-13)

609 Illuminating Engineering Nomenclature and Photometric Standards

5A Lighting News
Here and There with IES Members, 6A; Scheduled Events, 29A; About People, 30A; Books and Pamphlets, 64A.

35A Sustaining Members

66A Index to Advertisers

IES Officers and Committee Personnel — For 1958-1959, refer to April Issue of ILLUMINATING ENGINEERING. 1959-1960 listing is scheduled for the October issue.

STATEMENTS and opinions in articles and papers in ILLUMINATING ENGINEERING are the expressions of contributors and do not necessarily represent the policies or opinions of the Society. Official Society opinions are expressed only in official committee reports specifically approved by the Council of the Illuminating Engineering Society.

ILLUMINATING ENGINEERING SOCIETY

EDITORIAL and advertising offices
1860 Broadway, New York 23, N. Y.

PUBLICATION office 32d Street & Elm Avenue, Baltimore 11, Md.

Founded 1906

ILLUMINATING ENGINEERING: The Journal of the Illuminating Engineering Society. Copyright 1959 by the Illuminating Engineering Society. Published monthly in the United States of America. Entered as second-class matter at the Post Office, Baltimore, Md. Acceptance for mailing at special postage rates provided for in Section 1103 P.L.&R., Act of October 3, 1917. Authorized July 16, 1918. ¶ Subscription $18 per year plus extra postage to all countries to which second-class postage rates do not apply; single copies $1.50. ¶ Address changes must be received at I.E.S. headquarters by the first of the month to be effective with the issue of the next succeeding month.

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A Special Issue on the

National Technical Conference

IN THE LIGHTING FIELD, some information on what was presented at IES's National Technical Conference is getting to be an essential for anyone wishing to keep up with things. The past two years have marked one of the most fruitful development periods in lighting history—most of the new developments being presented initially at the IES Conference. Again this year, new techniques, new light sources, results of research, methods of calculation—all subjects presented for the first time in San Francisco—will point the way for future lighting trends.

For the benefit of those members who couldn't attend the Conference, and for reference for those who did, IE is again presenting all of the papers in capsule in this issue. These begin on page 548 and represent comprehensive abstracts of the full papers, prepared by the authors. They are presented in groups, as to general subject, for quick reference. For those who wish to discuss the papers in print when they are published later in IE, instructions on procedure for this are given on page 592.

Future direction of Society operation is eagerly awaited each year in the Presidential Addresses presented at the Conference. These are printed in full in this issue. President G. J. Taylor's Address starts on the following page; the Address of incoming President J. B. Browder begins on page 544.

Other highlights of the Conference will, of course, be featured in later issues of IE. Full text of the General Secretary's report to the membership is scheduled for December; the illustrated report of the Progress Committee will be in January IE; a full news report of the Conference will likely hit the November issue.

President's Report

By GEORGE J. TAYLOR
President, 1958-1959

LAST YEAR Council voted to hold the Society's Annual Corporate Meeting at the opening session of the 1958 National Technical Conference, in Toronto. It was the first time since the formation of the Society in 1906 that this event took place outside the State of New York. The Corporate Meeting at the National Technical Conference permitted a great many more members to participate in the activity, and I cordially invite your own participation here. I now call the 1959 IES Annual Corporate Meeting to order (in San Francisco).

Three of your officers will report to you this morning, and as has been customary, we will attempt to give you a condensed report of our stewardship during the fiscal year 1958-1959. We invite your comments and questions, your criticism of our past actions if you so desire, and your guidance for the year to come.

An Active Society

We have experienced an eventful and fruitful year with many accomplishments in several phases of Society operation. To relate them all would require considerable time and space. Perhaps the monthly column in IE "From the Desk of the President" has kept you informed currently of Society activities. It was so intended.

No attempt will be made in my report to single out the names of those men and women who did much in the advancement of our Society this year. However, I do want to express my sincere appreciation for the contributions in time and knowledge of these members.

Considerable time could well be devoted to the work this year of the Regional Activities Committee, under the able direction of Second Vice-President Dick Slauer. Let me briefly mention just three of their more important completed projects:

(1) A Past Chairman's pin was established to give the leaders of our Sections and Chapters permanent recognition for their valuable service. The badge is in the form of the standard lapel emblem to which has been added a panel bearing the words "Past Chairman."

(2) Six new Chapters of the Society were organized and chartered—Yosemite, Arrowhead, Central Florida, Central Kansas, Golden West and Buckeye. This is the largest number of new IES chapters ever formed in one year.

(3) Planning and carrying out of nine excellent Regional Conferences and one Special Conference in the Maritime Provinces, at Amherst, Nova Scotia.

There are two aspects of Society work which I would like specifically to emphasize, in reporting to you as President. These relate to (1) the intra-Society operations in the development of technical material — the Society's pronouncements, you might say, and (2) the external dissemination of this material, leading to its application for proper and adequate lighting practice.

As to the year's operation, it is fitting, in this regard, to start at Headquarters in New York City. You know, I believe, that we started this fiscal year with Dex Hinckley as Managing Director. Significant improvements have resulted from this move. It has been my privilege during the year to visit Headquarters frequently. It has been a great satisfaction to be so close and to see first-hand the many splendid accomplishments. No need to mention these beyond the fact that the "home office" is functioning as a smooth, well coordinated "business," rendering a greater service to our entire membership.

Mention of "membership" recalls the employment of John Michel as Office Manager, freeing more time for Dex to be in the field. Beyond

An Address presented at the National Technical Conference of the Illuminating Engineering Society, September 7, 1959, San Francisco, Calif.

this, much of John's time is devoted to rendering many types and kinds of service to our members. We're happy and proud to have John with us at Headquarters.

It is also important for you to know that in our new set up we have, in addition, the excellent work of our three Senior Staff members who head the major departments, Technical, Editorial and Advertising. These are, together with their assistants:

C. L. Crouch, *Technical Director*
John Kaufman
Ruby Redford, *Editor*
Barbara Lamson
Barbara Marwell
C. E. Ellis, *Advertising Manager*
Adelaide Philiba

Comprehensive reports from these Senior Staff members covering major accomplishments of their department activities were presented during the year to both Council and Council Executive Committee.

Further on the subject of Headquarters, I might mention that the invitation to move to the new United Engineering Center was carefully considered by the Council Executive Committee. Action at the June Council approved unanimously that IES accept space in this new United Engineering Center which will be located near the United Nations Building in New York City. This new office building, soon to get underway, will house about a dozen of the top recognized engineering societies in this country. Council's favorable vote is the result of a long, earnest and comprehensive study. There are many advantages in association with this new United Engineering Center. Among them are prestige, greater professional recognition, more adequate space, up-to-date lighting installations, accessibility to the world's largest engineering library and efficient and economic office operation, to mention a few.

Benefits and privileges enjoyed by members of a professional group always involve responsibilities. As an Associate in the United Engineering Center, we will participate in a campaign to raise part of the building fund, from our individual members. Three million of the estimated ten million building cost will be raised from contributions of the 250,000 members of the Engineering Societies. The successful outcome of the fund raising campaign will leave the Center free of mortgage expense, making the cost of our occupancy much lower in years to come. I invite the support of every member to this campaign for $75,000—when it gets underway this autumn.

Council

Just a few words about Council actions this year. First, the attendance was very good, averaging 77 per cent. It is quite important that Council members attend these all-important meetings so that a broad representation of views from both Canada and the United States can be properly and wisely expressed.

There has been considerable thought given in the past few years to reducing the required time and expense of Council members so that we might be assured of talented administrative representation. The first step in this direction was to hold the first Council meeting of the new administration at the location of the National Technical Conference. The first meeting of the 1959-1960 Council is scheduled to be held at the end of this week, here in San Francisco. Additional saving of time and work stems from the greater services and participation of Dex Hinckley as Managing Director, in Council matters and other duties generally imposed on officers of the Society.

Some of the more important actions by Council this past year were:

(1) Approval of a working budget and periodic financial review.

(2) Continued financial and Headquarters support of the Research Institute program.

(3) Establishment of the Headquarters position of Managing Director and appointment to this post of A. D. Hinckley, previously Executive Secretary.

(4) Review of the Society's relations with the AIA and NCSC co-sponsoring the American Standard Practice for School Lighting, and implementation of action to supply generally the Society's current recommendations on School Lighting.

(5) Approval of the Society's participation in the United Engineering Center.

(6) Review and approval of six reports submitted by Technical Committees.

I want to thank and commend Council for their careful deliberations and actions on the above items and on the many routine matters which were, nevertheless, important in the prosperous growth of our Society. We accomplished this year greater concentration on policy matters, the real function of our Council. Continued thought and effort along these lines is essential. My personal thanks goes to all members of Council and to those who acted as proxies.

There will be six members leaving Council after this fiscal year and these men I recognize by name as follows: Marshall N. Waterman, Joseph A. Schneller, J. Carl Wilson, C. C. Shotwell, A. Eugene Fleming, James A. Banton.

I would like to take this opportunity also to express my sincere appreciation to all chairmen of various committees and others who presented reports to Council. These presentations were excellent, using visual aids in most instances, (a point close to the heart of your President).

May I also extend my thanks to the Chairmen of all Sections, Chapters and to Committees—General, Standing and Technical—for a fruitful year. These thanks obviously carry on to each and every member of our committees.

Finally, my deep-felt appreciation goes to our Regional Vice-Presidents not only for their normal arduous duties but also for their extreme kindness extended to me everywhere I went.

The Budget

Many detailed problems arise concerning the financial structure of our Society as a non-profit organization. Our Finance Committee must be conservative in their judgment in the administration and delegation of finances for all phases of operation.

This year our financing was set up with a "deficit" budget due primarily to a conservative estimate of Society income (we have yet to see the effect of the recession), and secondarily to the expense involved in the implementation of the new Headquarters organization plan. Advance reports on our financial operations indicate that we will finish the year well in the black.

Evidence of the Society's financial stability is given in the success we have had in building and maintaining a reserve fund "to provide for security and continued operation of Society activities." Ten years ago we found it difficult to hold to the By-law requirement of 25 per cent of budget in reserve ($50,000). Now we have achieved a reserve of $150,000—close to our objective of a 50 per cent reserve. Incidentally this is in line with the practice of other engineering societies.

Membership

Perhaps the most important part of the Society's internal operation has to do with the Membership. To be sure, *this is* the Society. It was our hope at the start of the year to break through the four-figure barrier of 9,999 to become a society with a membership in excess of 10,000. The records show that our progress in adding members again followed the pattern of previous years. We'll end up with something slightly less than 10,000 members at our present going rate.

I am pleased to be able to tell you, however, that our net gain of 504 members this year is the highest one-year gain in the past ten years. I hope it represents the start of a steeply rising curve for the next ten.

Research Institute Campaign

We hold in very high regard our Sustaining Members, for through their contributions we are able to support many extremely important functions of IES. This year we suspended the usual sustaining membership drive and instead, have co-operated in a campaign sponsored by the Illuminating Engineering Research Institute. The results of this campaign are most gratifying. Many of our Sustaining Members are listed among those who responded by contributing to the support and continuation of researches on light and sight.

As I travelled to Regional Conferences this year, I had the pleasure of talking to about 100 Official Representatives of our Sustaining Members or to other company representatives. To these members I conveyed individually my personal appreciation for their splendid support over the years, indicating that through this means we have become a stronger, more important Society. I asked these representatives personally to convey this message to the Presidents of their companies and to Chair-

men of their Boards. Finally, I expressed the hope that those who published company Annual Reports would give thought to providing space in these publications to outline the benefits of good lighting. This is merely another means of getting the importance of lighting and researches to the many stockholders representing the public at large.

According to advance reports the Trustees of the Research Institute will succeed in their objective of $150,000, which together with the Society's help, will maintain an active research program through 1958-1959 and 1959-1960. To assist in the long range plans for the financing of the research program, Council confirmed my appointment of a Special Task Committee. This Committee, with Past President Kirk M. Reid as Chairman, is studying the long-range financial needs of the IERI program, and how they may be met.

The IERI has a very impressive list of projects underway, totaling 15 in all. These vary widely in scope but are of extreme importance to us in our knowledge for a greater understanding in the use of light for sight. Prospective projects contemplated for contract in the near future total 6.

Value of Research

While some notable contributions in terms of research projects have been made in the past by the Research Institute, none has had so great an impact as the study by Dr. H. R. Blackwell on "Development and Use of a Quantitative Method for Specification of Interior Illumination Levels on the Basis of Performance Data." Dr. Blackwell's complete report on this research work appeared in the June 1959 issue of ILLUMINATING ENGINEERING.

This study is an excellent indication of what research in lighting and seeing can provide for us and how we, as IES, can interpret and make available technical information for practical application.

I would like to make one thing clear with respect to IES and IERI. These two organizations operate as separate entities and yet have integrated and coordinated programs. The function of IERI is to plan, supervise and underwrite research projects, the results of which are passed on to IES for interpretation and publication. In the procedure generally followed, research reports are taken up by the RQQ Committee, which is composed of all chairmen of IES Technical Committees. This committee interprets the research studies, as in the case of the Blackwell Report, and presents its evaluations and recommendations to Council for consideration and approval.

Let there be no misunderstanding about any research projects and studies now under way or planned for the future. They will be considered for their usefulness to the illuminating engineering profession. They will be designed to present the facts of light and sight within the normal scope of research. The Blackwell studies as presented by IES in terms of footcandle values for specific seeing tasks are based on 5 APS (assimilations per second). The studies, however, also included data for 10 and 30 APS. The more refined levels of perception would require much higher levels of illumination for corresponding tasks. Our RQQ Committee selected 5 APS as a present criterion for visibility. It should be emphasized that, with a continuation of this research project, a higher APS, or perhaps some entirely different scientific approach, might well lead to increased illumination values.

There is before us right now another exciting series of research studies on reflected glare which may further change our past thinking. Reflected glare has ever plagued us. Yet our knowledge of it was scant, to say the least. We merely realized that it was undesirable. To what extent we have never known with accuracy, but we'll soon have a scientific answer to this enigma thanks to a research project being conducted by Professor Dan Finch, John Chorlton and Hedley Davidson. Already we know from their many experiments that unless concentrated downward components are controlled at the source, there will be difficulty in seeing tasks that have even minimum specularity. Pencil-writing is one simple example which may require 200 per cent more footcandles to compensate for uncontrolled downward light.

So, you can see and appreciate the value of research and technical appraisal of such studies in our future analysis of the eyes' response to quantity and quality of lighting.

IES Lighting Handbook

The one single source, within one cover, for all of the recommended illumination levels is the *IES Lighting Handbook*. This is for you—and for everybody concerned with the proper application of lighting. The third edition of this masterpiece has recently been made available. It was scarcely on the presses for 10,000 copies, when we had to place a second order for 5000 additional copies. We should feel pleased that the first printing was so quickly exhausted. However, we must remember that even when all 15,000 copies are distributed, we shall still be a long way from getting this valuable document into the hands of the many who "specify" lighting for all purposes of seeing. I would urge you to assume the responsibility of

getting copies of our new Handbook distributed to the 100,000 people who really need them. There are many ways to do this beyond that of promotional effort and sale. One simple way is to give them away in sizeable quantities as birthday or Christmas gifts, or for no designated reason at all. It would be difficult to find a better or more satisfying way of benefiting the lighting profession.

May I just inject a word of praise to one who has devoted untold hours in so many different ways to achieve perfection for the Handbook. To be sure many should be mentioned, but John Kaufman at Headquarters was the man behind the scenes who has read every word and checked every number printed to give to you the world's greatest compilation of lighting data.

Although the material in the Handbook is, by and large, the work of our Technical Committees, it does not in any way measure the contributions made by these committees. I shall refrain from listing here the accomplishments of our Technical Committees and leave this for Joe Browder who, as First Vice-President, will report these activities.

The same goes for General and Standing Committees. Our General Secretary, Jim Chambers, will do the honors in reporting accomplishments of these groups. His report, generally published in the December issue of IE, will cover the broad aspects of local activities among many other things as well as detailed Technical Committee reports.

A Tribute

And now, before leaving the subject of how our Society has matured as a progressive professional body in the past year, I want to say a few sincere words about our sister Society in England. The British IES is now celebrating its Golden Jubilee. In behalf of you, the American membership, I extended to our British counterpart best wishes and congratulations on passing its 50th milestone. These greetings, you will doubtless be happy to hear, were graciously received there earlier this year, and were published in Volume 24, No. 1 (1959) of the *Transactions of the Illuminating Engineering Society*, London.

An Outside Look

Now, let's turn from our inside look at IES's operation and focus for a few minutes on its contributions to mankind at large. From today's review of some of our activities during the past year, it must now be apparent that our Society is ably discharging the function of providing lighting information in the form of reports, papers and recommended practices. These are available to any interested organization, institution or individual. They are the result of the work of carefully selected members forming various committees, the works of which become available through an efficient Headquarter's staff, after Council approval.

Disseminating Information

How extensively do our many forms of dissemination reach the field forces who are ultimately responsible for the application of lighting? This question led me to make a plea, if not a platform, during my year as President. Why? Because I have a strong feeling that we have not made ourselves heard or understood by enough people who use light. My plea—"IES to the Public!"

How do we disseminate information? By means of many printed publications, and especially through ILLUMINATING ENGINEERING, the best in the land. Also by way of local meetings, Regional and National Conferences. All these are educational necessities in reaching our own circle of IES members. But our scope should be broadened far beyond this. I say "far" because we do reach some people outside our membership but the coverage appears to be much too restrictive. Why? Information is available indicating that only about 20 per cent of the residential, commercial and industrial applications are lighted to our past recommended lighting levels. The percentage meeting our new footcandle recommendations must be pathetically low.

To whom should we look in getting our story across to the ultimate user of lighting? Let me list a few.

(1) Direct manufacturers — lamps, fixtures, accessories
(2) Allied manufacturers — metals, glass, plastics
(3) Interested manufacturers — paints, floor and wall coverings
(4) Indirect manufacturers—machines, furniture, pictures
(5) Contractors — General and Electrical
(6) Architects, Consulting Engineers, Decorators
(7) Distributors, Dealers
(8) Electric Utilities

Without even attempting an accurate figure, it would be reasonable and conservative to say that this group totals in excess of 200,000 who in one way or another have some direct influence on how much and what kind of lighting will be used. If this be true, there should be some closer tie with this group, they should have a much greater interest in our Society activities. This interest could be through IE subscriptions, greater

use and distribution of our technical publications, broader and more active participation in our meetings, and above all, IES membership.

These are just a few of the avenues of "I.E.S. to the Public." The next and extremely important step is through the strength of the press and here I suggest three approaches: Technical Magazines, Popular Magazines, Newspapers.

Our meeting records show an attendance of some 80,000 annually for all types of IES meetings. Since each Section and Chapter holds about 8 meetings each year, and generally the same people attend them, we may not be reaching much more than 10,000 people through our meetings. Do not misunderstand me, these meetings are the most vital of all in teaching *our* members and keeping them up-to-date on the science and art of illumination. However, a still further step would be passing on this knowledge to the specifier and ultimate user of lighting. Many of our members do an outstanding job in this connection but the coverage in expounding the facts of light is not extensive enough. To put it bluntly, we are only scratching the surface in getting across the true value of good lighting.

A Good Start

I am delighted with the response to my plea for getting the story of lighting to the public. A high percentage of the 88 Section and Chapter Chairmen replied to my request. I wish it were possible to reproduce some of the letters written to me, describing determined efforts to reach outside interests such as Civic Clubs, High Schools, Universities, Parent-Teacher Associations, Industrial Groups, Electric Leagues, Architectural Competitions, with lighting courses, television and radio, displays and many, many other varied types of activities.

Perhaps the most enthusiastic Section was this: "During National Electrical Week our members spoke to 13,421 people consisting of students, architects, engineers, hospital personnel, city engineers, electrical contractors, plumbers, general contractors, restaurant associations, garage associations and small manufacturers, concerning the necessity of good lighting and its application."

Others reported holding up to 23 meetings with outside groups such as listed above. We have no records as to how many "outside" people heard the story of lighting but the total appears to be impressive and gratifying. About 1000 delegates of the Edison Electric Institute heard and saw a lively demonstration of the merits of adequate lighting levels in early March of this year.

The dedication of the new State Street lighting system in Chicago last November, attracted approximately 300,000 men and women to see the turning on of the new fluorescent lighting. A platform was erected at State and Madison for the purpose of portraying the developments in "light through the ages."

I would like to pay tribute to the Chicago Lighting Institute for the excellent progress made in disseminating lighting information last year to more than 6000 people in about every business activity.

I have always held a soft spot in my heart for the fine work done by our Residence Lighting Forums. There are now 13 such Forums located in major cities in the United States and Canada. A wide variety of interesting programs on the subject of home lighting and decoration have been offered this year and have reached a sizable number of people in all walks of life.

In the field of publicity on lighting in the form of articles and editorial comment, we feel this was a banner year. Chief reason was the Blackwell researches and the new IES current recommended footcandle levels.

Another popular means of bringing the story of light and lighting to the public is in displays and exhibitions. As one example, this year the National Lighting Exposition was held in New York City for four days. A total attendance of 17,000 was reported. A unique series of symposia were held in conjunction with the Exposition having 38 well-known experts on lighting as speakers—almost exclusively IES members. There were 12 subjects discussed with a total audience of some 6000 from all over the country.

The task of public education on lighting has met with success this year—a good start. We must not stop or slow down in our endeavor to get millions of people to understand the true advantages in the use of proper illumination.

Last winter I wrote to a large number of organizations in the United States and Canada asking for photographs of lighting installations that equalled or exceeded our new footcandle recommendations. Scores of photographs were received covering almost every conceivable application. The progress manifest through these installations was very very gratifying.

Conclusion

It has been customary for Presidents in the past to list recommendations, suggestions or questions directed to the incoming administration.

(*Continued on page* 547)

Report of the Vice-President

By JOE B. BROWDER
President, 1959-1960

OURS IS A technical Society and my report will deal primarily with our technical progress during this past fiscal year. Because of time limits, only the high spots may be touched, but I sincerely hope that in the next ten or fifteen minutes I can convey to you just a little of the awe and wonder that I have experienced this past year, while observing the more than one hundred technical committees and subcommittees at work.

Over 700 men and women serve on these committees. I would be doing a disservice to those who carried the largest load if I said that they *all* gave freely of their time and energy, but I can tell you that a large majority of these people did really devote themselves to the never-ending job of technical progress in our Society.

It is in some ways a thankless job, and all too often an improperly recognized one. Occasionally it is even a job that brings criticism for their hard work! Why do they serve? Why do they give so freely of themselves year in and year out? Permit me to guess. Some are serving to have the chance to learn; some to teach others; some to have the chance to make new friends and influence more people, some for the pure love of being a part of lighting progress; some for business reasons; some for the sole purpose of contributing their bit to the whole; some merely to accommodate the chairman who appointed them. Some of them are "on fire" and must have a forum for their ideas. There are even some who serve to impress the boss! Most of them are a composite of several of these and other reasons, but there is one reason I believe common to every one who is at all active or desirous of the time to be active—love for the IES.

There is some intangible something about IES that makes it quite different from most other organizations. We work harder, play harder; we do more, and we are more closely knit than most groups. I think I know at least part of the answer to this one. You might at this juncture be properly asking, "What kind of technical report is this fellow making?" Be patient; it all ties in and I hope will be technical enough for you without the use of figures.

What bonds people together? A common cause, a common disaster, to name a few. The news picture of a chicken and a large rattlesnake floating together on a log in a flooded stream is fine proof of the bonds of common disaster. Perhaps this is not too exaggerated a reason for the case of the IES.

An Address presented at the National Technical Conference of the Illuminating Engineering Society, September 7, 1959, San Francisco, Calif.

No American or Canadian university offers a degree in illuminating engineering. To me that is a disaster. There are illuminating engineering options, to be sure, but no degree.

When our Society began in 1906 the art and science of illuminating engineering was very meager. There was considerable knowledge of the physics of light. Lens systems were understood, and there were crude attempts to apply these theories and principles commercially.

The IES began assembling this knowledge, evaluating it and then improving upon it. Over the years more and more people with special knowledge, special skills, and special talents flocked to our banner. Today the Society counts among its members the finest technical minds in Canada and the United States, engaged in the pursuit of lighting knowledge.

IES is unique among most engineering Societies because it is *creating a profession* where one did not previously exist. In the case of the so-called "founder societies," the Society, or organized group, *followed* the professions. The profession already existed and was organized into a Society at a later date. This is even true of the medical societies and many others. The IES is literally carving a profession from facts, research and application.

Today's lighting application engineer is backed up with a wealth of research and years of experience of hundreds of people bonded under the common cause of IES.

The *IES Lighting Handbook* is proof of our

uniqueness. Few Societies attempt such a work as this. It is monumental in scope and represents untold thousands of man-hours, and women-hours, of hard work. It is the "bible" of the lighting application engineer. It is a published declaration of our Society that commands respect and is something of which we should all be very proud.

This past year has been one of "digestion." Last year in March, we had a revolutionary new method of appraisal of visual tasks presented by Dr. H. R. Blackwell at the Illuminating Engineering Research Institute Symposium at Dearborn, Mich. Our technical committees immediately began to consider possible changes in recommended levels of illumination. As a result of measurements on 56 tasks from various application fields, they arrived at recommended levels that were approved by Council in June and published in the August issue of ILLUMINATING ENGINEERING.

Thus, the year ended with new levels but with scarcely any thinking as to what these levels would mean when actually applied to practice. Since the new levels made obsolete nearly all our recommended practices, our application committees immediately had to start to think in terms of revisions, revisions that would not only comprehend the use of radically new higher footcandle levels but would also consider the environmental conditions that would *have* to be provided to make sure that these levels would achieve the increased visibility for which they were designed.

Coincident with the development of footcandle levels, the IERI has been studying and presenting new knowledge in relation to quality of illumination which would tie in with the use of the new levels. For instance, intensive studies were made on the effect of reflections of overhead lighting in the details of the work, such as tasks in schools and offices. Here, the Institute has found serious losses of visibility from overhead lighting equipment which allows a raw light to come down directly to the task. This loss of contrast is the equivalent of throwing away a large percentage of the footcandles on the task. Our committees have begun to think in terms of adequate safeguards by reducing the concentration of the downward light and thus preserve the effectiveness of the new higher levels being delivered.

Preliminary results from a study of discomfort glare from large area sources, such as windows and large luminous areas of electric lighting, indicate that these should be limited in the brightness exposed toward the eye to a relatively low degree—in the neighborhood of 350 footlamberts.

The Practice committees have been engaged with a study of the effective use of the higher levels of illumination through adequate safeguards of quality of light. The *Office Lighting Practice*, even though produced in 1956, is being revised and it is expected that this will probably be the first one ready for public use. The Industrial Lighting Committee has taken the ASA Sectional Committee, composed of representatives of other organizations, into its confidence and presented in a day-long session, the Blackwell research, the resulting new levels, the new techniques of industrial lighting, and improved quality through greater increase in upward components. This was the first step in the revision process, obtaining comments from these and other organizations as they set about their task of revision.

The Roadway Lighting Committee has called upon the Research Institute to make measurements of typical obstacles as potential accident precipitants under actual street and highway lighting conditions. This work is already being carried out, and it is expected that it will form the basis for the new revision of the *American Standard Practice for Street and Highway Lighting*.

The School Lighting Committee, together with the American Institute of Architects and the National Council for Schoolhouse Construction, is in the process of evaluating the impact of the new proposed levels on the *School Lighting Practice*. They are vitally interested in the losses due to reflections

of overhead lighting equipment on pencil work in the classrooms.

The Store Lighting Committee is revising its Practice in terms of measurements made by Dr. Blackwell of typical tasks of appraisal of merchandise in the various types of stores.

All of this work means nothing unless it is received favorably by other organizations that will support the new levels of illumination and their application. Thus, a series of talks has been given by Dr. Blackwell, the officers of the Society, and the Technical Director, to special meetings of architects and consulting engineers called for this purpose. National Conferences have been addressed and told the reasonable story of research and results. Some of the organizations are: Building Research Institute, National Lighting Exposition, Edison Electric Institute, Southeastern Electric Exchange and National Electric Distributors Association. Prominent trade magazine stories have also appeared, led by an outstanding presentation in *Architectural Forum*.

Thus, this new knowledge, backed by the soundness of objective research at the university levels, is catching fire in interest and enthusiasm throughout the lighting world and is spilling over to our neighboring organizations who are concerned with the design of luminous environments which affect the human organism.

The accompanying table shows a list of technical committee reports for the year just completed.

Here and now is the proper place to give praise and recognition to our Technical Director, Cash Crouch, and his able assistant, John Kaufman. They have given of their talents far beyond the usual eight-hour-day observed by most people. Our Society is indeed fortunate to have the capable and devoted services of these two gentlemen serving on our headquarters staff. The other staff members are deserving of the same praise, even if this is a technical report.

The Year 1959-1960

As President-Elect, I would like to say a few words about the coming year and some of the things we shall attempt to bring about. President Taylor, like Past-President Reid, did not in his year-end report leave us a list of recommendations or suggested objectives, but he did start a number of things that certainly are worthy of finishing. Under George Taylor's administration the reorganization of the headquarters staff was accomplished. This was an excellent move and deserves every support for continued refinement and further workability from the new administration.

Also under President Taylor's guidance a decision was made for us to become a part of the great new United Engineering Center now under con-

Technical Committee Reports, 1958-1959

Published

IES Lighting Handbook, Third Edition
Reaching for the Sun (Progress Report)
Evaluation of Direct Discomfort Glare in Lighting Installations—Report No. 6 of the Committee on Standards of Quantity and Quality for Interior Illumination
Guide for Reporting General Lighting Equipment Engineering Data
Recommended Practice for Marine Lighting
Illuminating Engineering Nomenclature and Photometric Standards
Laboratory Activities with Light

Scheduled for Publication

Lighting for Low-Ceiling Classrooms
IES Guide for Photometric Measurements of Mercury Lamps
IES Guide to Design of Light Control

Reports Submitted to Council*

Practical Guide to Colorimetry
Addendum to Guide for Life Performance Testing of Fluorescent Lamps
Recommended Practice for Outdoor Parking Area Lighting
Outline for a Training Program
Lighting Keyed to Today's Homes
Recommended Practice for Daylighting
Recommended Practice for Sports Lighting
Recommended Practice for Airport Service Area Lighting

Active Reports (Partial Listing)

Lighting Fundamentals Course
Lighting Design Problems Course
Recommended Practice for Office Lighting
Recommended Practice for School Lighting
American Standard Practice for Industrial Lighting
Store Lighting Guide
Recommended Practice for Church Lighting
Color Rendition
Nomenclature Revisions
American Standard Practice for Street and Highway Lighting
How to Make a Lighting Survey
Guide for Photometric Testing of Outdoor Fluorescent Luminaires
Guide for Photometric Testing of Mercury, Incandescent and Sodium Street Lighting Luminaires
Practical Guide to Brightness Measurements
Guide for Interpretation of Test Data
Guide to Method of Measurement of Fluorescent Lamp Starting
Guide for Investigation of Methods and Techniques of Measuring and Reporting Tests of Reflector Lamps
Progress Report

*Not ready for publication.

struction in New York City. For us to be a proper part of this great venture, we should do our fair share in raising funds. The Council, after very careful consideration decided we should raise $75,000. This chore falls upon the new administration and must be taken seriously if we are to succeed.

The most important thing started by George, in my opinion, is his theme "IES to the Public." This is a job that will never be finished, but one that should constantly occupy our thoughts and be a part of every plan we make. Our Public Relations and Information Committee has a staggering job ahead with meager funds to implement their plans. We all must pitch in and help get IES to the public. Our research and application knowledge mean little if they are unknown, obscure, and not applied. The public would demand better lighting if it knew what each of us knows. I have often said there are three kinds of public relations — good, bad, and none. Ask 100 men on the street what IES stands for and you will have the answer to what kind we have.

When I was in the United States Naval Academy, we had a great seal with the motto — *Ex Scientia Tridens* (from knowledge, sea power). Perhaps we could use the same motto with a slight change of spelling from "sea" to "see" power!

Conclusion

You have bestowed a great honor upon me by electing me as your 55th President. I am made humble and filled with pride to do the best job I know how to do. I feel many emotions as I think about the tremendous job ahead. The men who have preceded me number among them such greats as L. B. Marks, Charles P. Steinmetz, E. C. Crittenden, Ward Harrison, Matthew Luckiesh and many others just as great though perhaps not quite so well known.

When Steinmetz was President in 1915-1916, there were five Chapters. Today there are 88. The Society today is bigger than it ever has been with more Sections, more Chapters, and more members. The technical progress is accelerating at an even faster pace. We must keep moving and keep growing in strength as well as size. I fully realize the job that is to be done and I pledge to you that regardless of time or energy, I will give it the most of these things that I have to give.

Taylor—President's Report

(*Continued from page* 543)

I shall break this precedent by making only one recommendation, that is to eliminate any form of recommendation in Presidential reports. Instead I have written a special report for the Officers of the Society for consideration by the President's Advisory Board. It must be remembered that many projects have been started which will be completed in the next administration and some may carry on beyond. The officers work closely together on all matters of importance. Today with the many problems facing a large and growing Society no one person can suggest major recommendations that should have been under constant progressive study during the year.

At Toronto I expressed the opinion that we have the nicest, most friendly people as members of our Society. We take our Conferences seriously and we know the value of fun and gaiety. This thought has been verified to me and my wife Olive as we toured the two countries of our Society membership. The friendliness and kindliness extended to Olive by the ladies and to me by those who attended the Conferences shall never be forgotten. The same may be said of our meetings in between Conferences. Thank you all, IES members, guests and friends for a wonderful experience. May God bless you as you continue to preach the gospel of what I feel is one of man's most important assets in life—*light*.

Light Sources

The Role of Crest-Factor In Lamp Starting

G. A. Meyers

J. C. Heffernan

Use of rapid-start lamp types having heavier loadings has focused attention on ballast parameters, such as crest-factor, which influence lamp starting. The starting aid potential applied between the starting aid and the high potential cathode is instrumental in establishing a minute initial discharge within the lamp which is a necessary part of the starting mechanism. Tests were run in which starting aid potential was derived from an electronically generated complex wave, having a starting pulse of variable width, height and phase. It was found that minimum starting aid potential could not be attained with pulse widths shorter than about 40 degrees, as shown in Fig. 1. Starting aid voltage can be best expressed as a peak voltage. It is temperature-dependent but independent of the rms value of open-circuit voltage and is the same for all lengths of lamps and types of circuit.

The ballast must have a volt-ampere characteristic in excess of that of the lamp with heated cathodes, as shown in Fig. 2, but an excess over the cold-cathode characteristic will result in instant-starting with consequent cathode damage. This cannot be avoided in outdoor service but the long burning cycle helps to compensate for instant-starting.

Ballast crest-factor will be determined by the required values of peak starting aid potential and the rms voltage required across the lamp for operation, and need not be arbitrarily limited. A further specification based on wave-shape may be necessary in order to insure the maximum degree of proper starting under service conditions.

(Abstract of IES Conference Paper No. 20.)

Authors: Sylvania Lighting Products, Danvers, Mass.

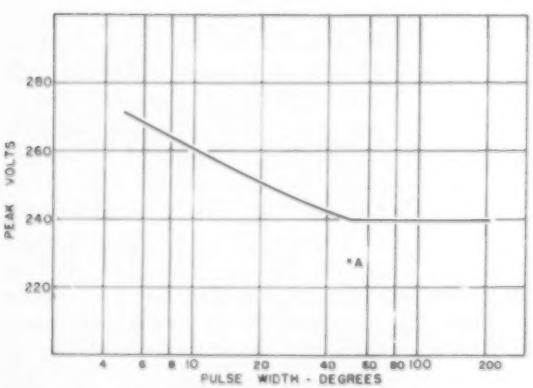


Figure 1. Starting aid voltage (peak volts) as a function of pulse width.

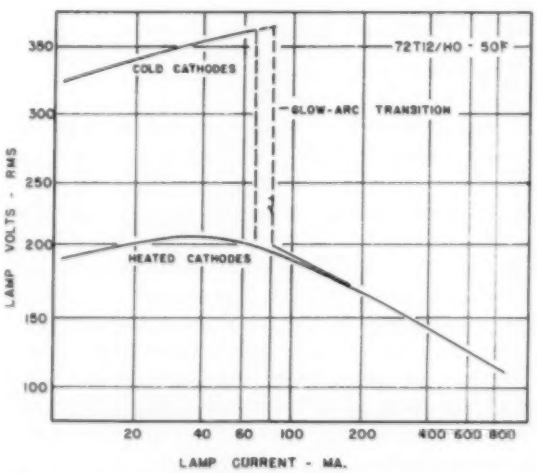


Figure 2. Volt-ampere curve for hot and cold cathode operation.

External Control of

Mercury Pressure of Fluorescent Lamps And its Application to Luminaires

P. J. Underwood

C. E. Beck

LIGHT output and performance of fluorescent lamps vary with the surrounding ambient temperature. This is the result of a change in mercury pressure within the lamp as the bulb-wall temperature changes with the ambient temperature. Fig. 1 shows the light output curves for a 96T12 lamp operating at various currents as a function of ambient temperature.

The importance of mercury pressure in fluorescent lamps has been recognized by lamp engineers who have designed lamps to give close to the maximum light output and luminous efficacy under the standard test conditions of 77F still air. However, when lamps are operated at higher than normal ambient temperatures, considerable gains in light output are possible if the mercury pressure could be kept at the optimum value of the lamp. Under these conditions external means can be used to cool a portion of the bulb to a temperature which will give higher light output. Almost any heat transferring method can be used.

Studies indicate a simple approach to the problem is a metal shoe contacting the bulb wall and transferring heat to a metal fin which is cooled by the air. This combination of metal shoe and fin has been referred to as a "sail."

Many "sail" designs were tested and some specific recommendations can be given. Furthermore, the tests indicate such devices can be successfully incorporated into new luminaire designs.

Fig. 2 shows the cross-section of a luminaire to which two louvers have been spring-loaded and equipped with metal shoes to contact the bulb wall. They effectively reduced mercury pressure in the lamp at higher ambients. For example, gains of 8-18 per cent were obtained in a closed recessed troffer for ambient temperatures around the lamps of 112-114F. In an actual office 96T12 high output lamps, used in open top luminaires in which "sails" were incorporated, showed a gain of eight per cent in light at a room temperature of approximately 80F.

While cooling devices are simple, the conditions of operation and installation as well as the luminaire design must be taken into account in applying them. Indiscriminate use of external cooling devices might result in unfavorable operating conditions. Experience indicates considerable ingenuity and test work may be necessary before arriving at a luminaire design for a particular condition of operation. However, the gains in many cases would make it worthwhile.

(Abstract of I.E.S. Conference Paper No. 3.)

AUTHORS: General Electric Co., Cleveland, Ohio.

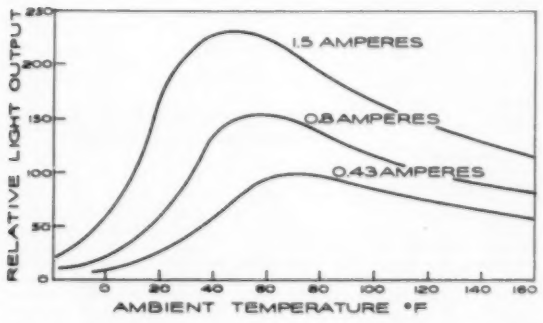


Figure 1. Light output versus ambient temperature of a 96T12 lamp at various currents.

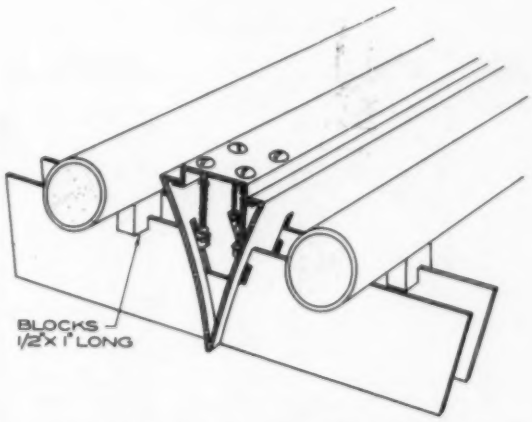


Figure 2. Spring-loaded louvers with cooling contacts section through center of luminaire. The rest of the louvers are normal.

Phosphors for Electroluminescent Lamps

Lester W. Strock

ZINC SULFIDE is a very versatile and useful phosphor material. Like all photoluminescent phosphor its color and other properties are determined principally by its chemical composition. When the crystal structure of photoluminescent phosphors is disordered in a certain unique manner, they develop a new property of emitting light when placed in a relatively strong electric field. Thus, the introduction of crystal disorders converts a *photoluminescent* ZnS phosphor to an *electroluminescent* phosphor which, when made part of a thin (few mils) electrical condenser, has been engineered into an area light source.

Several types of structural disorders are possible in ZnS crystals, some developing during crystal growth, others resulting from mechanical working or thermal treatment of a disorder-free crystal.

A common type of disorder results when a hexagonal crystal undergoes a partial phase transition to cubic structure in such a way that vertical pairs of Zn-S atoms move to new positions. Crystals containing such disorders have mixed cubic-hexagonal x-ray structure and optical birefringence lower than the pure hexagonal phase.

A second type of disorder, occurring less frequently, subdivides the crystal into thin slices of different birefringence levels. This second type results when a single atom-sort (Zn or S), rather than a Zn-S pair, changes position to an alternate four-fold position which disrupts the tetrahedral bonding pattern of the crystal. This disorder type is responsible for the banded birefringence boundaries.

A third type of disorder, illustrated in Fig. 1, provides a model for describing the mechanism of activition and light emission of electroluminescent phosphors. Types two and three disorders involved single-atom sort displacements. In type three, the displaced atom moves into a six-fold structural position which leaves both a Zn-atom and a S-atom with an unsatisfied or "broken bond"—both having three additional neighbors at slightly greater distances than their three tetrahedrally bonded ones.

The additional criterion of structural disorder in the case of electroluminescent phosphors is responsible for the many special properties of these phosphors which had to be investigated as part of a program for development of suitable phosphors and fabrication of usable lamps.

(Abstract of IES Conference Paper No. 12.)

AUTHOR: Sylvania Lighting Products, Salem, Mass.

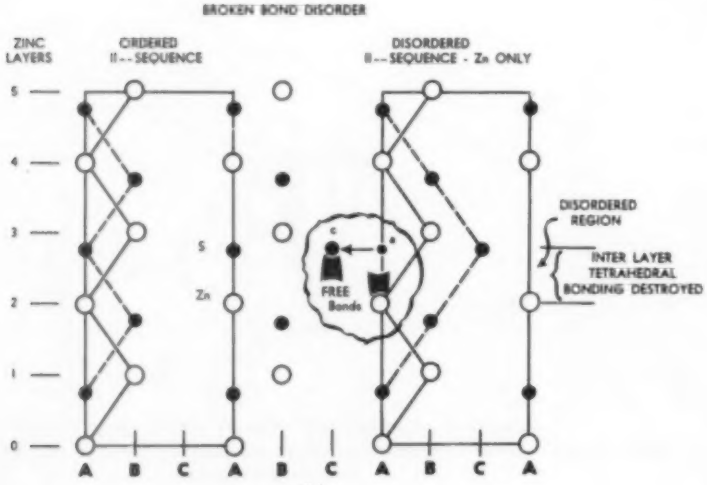


Figure 1. Single-atom layer displacement in hexagonal ZnS.

Electrostatic Coating of Silica On Incandescent Lamp Bulbs

N. J. Rainone

In the year 1948, the use of silica applied to the inside surface of an incandescent light bulb was introduced for the purpose of obtaining good light diffusion. The resultant product was not only functionally superior to the standard inside frost bulb but also enhanced the appearance of the lamp. There are several known methods of applying this silica coating. They are as follows:

(1) Mixing silica with a liquid binder and applying as a flush.
(2) Burning an organic silicon compound and collecting the smoke.
(3) Spraying onto a hot bulb, an alkaline reacting silica aquasol carrying large silica powder.
(4) Electrostatic deposition of a dry silica powder.

The purpose of this paper is to describe the electrostatic process, its advantages and the advantages of the resultant product.

In brief, a finely divided silica powder is mixed with air to form a smoke. The smoke at a controlled pressure is directed through a jet or nozzle into the interior of the bulb to be coated. Just prior to this, the surface of the bulb is heated to render it electrically conducting. Simultaneous with the blowing of the silica smoke into the bulb, a high potential is applied between a probe positioned within the bulb and the outer electrically-conducting surface. This causes the silica to be deposited in a uniform fashion on the inner surface of the bulb to produce a greatly superior coating. After coating, the bulb is heat treated to remove moisture and then made into a lamp.

The performance of any diffusing coating can be evaluated by the amount of diffusion effected as compared to the percentage of transmitted light. Data are presented which show that electrostatic coating light diffusion efficiency is greater than any of the other known methods of coating. The basic difference is that the coating applied electrostatically permits close control of packing density and results in a "fluffy" coating. In other coating

Author: Westinghouse Electric Corp., Bloomfield, N. J.

TABLE I — Coating Densities.

MATERIAL	COATING BULK DENSITY (gm/cm³)			DENSITY RATIOS (Coating bulb density divided by true material density)		
Silica electrostatically applied	0.094	0.040	0.065	0.043	0.018	0.030
Burned ethyl orthosilicate	0.124	0.1	0.112	0.057	0.046	0.051
Silica aquasol-admixed large silica particles	0.37	0.31	0.34	0.17	0.14	0.15
Silica applied by flush technique	0.38	0.25	0.30	0.17	0.11	0.14

Note: The above table lists coating bulk-densities for various different materials, as coated onto a 100-watt size envelop. In obtaining these readings, lamps were broken under carefully controlled conditions (room temperature and 10-12 per cent humidity) so that results would be consistent. Bulbs were split axially and the thickness of coating measured microscopically. Powder weight was determined by weighing the bulbs with and without the coating. Knowing the weight and thickness of the powder and the area of the bulb, the bulk density was calculated.
Extremes as indicated are due to mean variations from lamp to lamp.
Silica true density used in calculation was 2.2 gm/cm³.

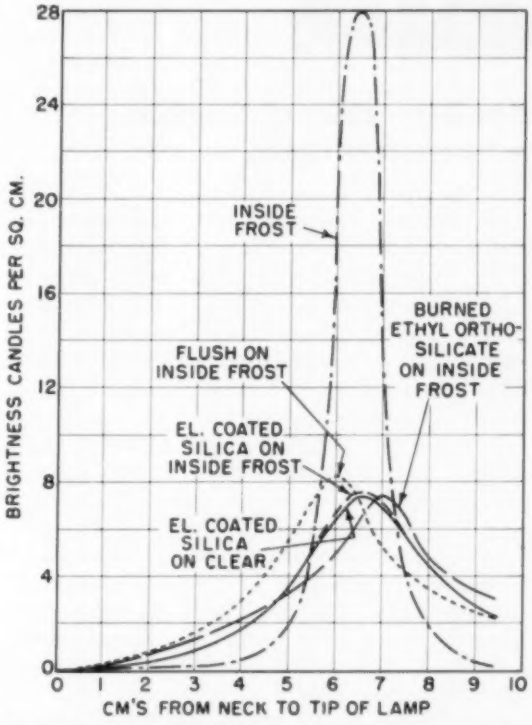


Figure 1. Observed brightness in candles per square centimeter versus distance from the neck of the bulb to the top, measured in a plane perpendicular to the filament. Curves show the relative diffusing effect of the various methods of silica-coating versus the inside-frosted lamp.

processes, a liquid or vapor is present, as a carrier or a by-product incidental to the operation, which serves to pack the powder tightly to the bulb surface. This results in a dense coating to obtain sufficient diffusion.

Table I shows the comparative coating bulk densities. Fig. 1 shows the reduction of hot spot or a measure of the diffusion. Table II shows the transmission efficiencies.

(Abstract of IES Conference Paper No. 18.)

TABLE II — Transmission Efficiencies.

Lamp Bulb Type	Transmission Efficiency
Standard light source	100%
Clear-glass bulb	99%
Acid-etch, inside-frosted bulb	98.9%
Electrostatically-applied silica coating on clear-glass bulb	97.2%
Electrostatically-applied silica coating on inside-frosted bulb	97.2%
Burned ethyl orthosilicate on inside-frosted bulb	96.3%
Silica aquasol—large silica particles sprayed on hot inside-frosted bulb	95.5%
900C fired silica powder flushed on inside-frosted bulb	96.7%

Charles W. Jerome

Slow Decay Rates of Phosphors In Fluorescent Lamps

MOST PHOSPHORS have been shown to exhibit a twofold decay. There is a very fast decay which reaches completion in times of the order of a few microseconds followed by a relatively slow decay. The study shows that the fast decay component is the determining factor for flicker in these lamps on a-c operation, and, in most cases, is the blue color component of the phosphor.

In this study, 40-watt fluorescent lamps were operated on both direct and alternating currents. The light output was picked up on a photomultiplier tube corrected to eye sensitivity and presented on an oscilloscope. Pictures were taken of the behavior of the light output when the circuit was interrupted, and from these the decay rates of the slow decay component of the phosphors were determined. This was done by finding the exponential equation: $I/I_o = e^{-kt}$ which best fitted the observed data. In this equation, k = the "decay constant," t = time in seconds, and I_o is the intensity after the fast decay has reached completion. These values, together with the flicker information are listed in the table. In all these phosphors, the red emission band, and therefore the slow decay component whose decay constant is listed in the table, owes its color to the use of manganese as the activator. It is concluded that the different decay rates are therefore due to modifying effects of the crystal matrices of the different types of phosphor. For example:

In calcium halophosphate (standard colors) $k_{Mn} \sim 65$

In calcium silicate (deluxe colors and Soft White) $k_{Mn} \sim 40$

In zinc O-silicate (green) $k_{Mn} \sim 215$

In cadmium borate (pink) $k_{Mn} \sim 70$

This study has indicated that the rapid decay component of fluorescent lamp phosphors is the principal cause of flicker in these lamps on a-c operation; that the blue phosphors have only a very rapid decay giving rise to 100 per cent flicker; and that the decay rate of manganese is modified over a considerable range by the crystal matrix making up the phosphor.

(Abstract of IES Conference Paper No. 17.)

Decay Rates of Phosphors in Fluorescent Lamps.

Color	Per Cent Flicker IES Handbook	Per Cent Flicker Observed	Per Cent Fast Decay	Slow Decay Seconds to Reach .01 I_o	Slow Decay Decay Constant
Standard warm white	20	17	33	.05	70
White	25	22	36	.05	65
Standard cool white	34	31	48	.05	61
Daylight	50	53	70	.06	65
Warm white deluxe	20	23	37	.075	39
Cool white deluxe	34	38	54	.045	46
Soft white	30	46	63	.05	33
Super deluxe	—	91	95	—	—
Calcium silicate (Pb, Mn)	—	17	29	.10	33
Cadmium borate (Mn)	—	24	39	.075	72
Zinc silicate (Mn)	—	26	41	.0075	215
Magnesium tunstate	—	100	100	—	—
Barium silicate (Pb)	—	100	100		
Calcium tungstate (Pb)	—	100	100		
Barium titanium phosphate	—	100	100		
Calcium-zinc phosphate (Sn)	—	100	100		

AUTHOR: Sylvania Lighting Products, Salem, Mass.

Tensile and Thermal Stresses in the Envelope of High-Brightness, High-Pressure Discharge Lamps

Wolfgang E. Thouret

HIGH-BRIGHTNESS mercury or xenon discharge lamps with extremely high operating pressure have been developed since 1935 in Europe and in this country. Their main advantage is that they combine the high brightness of carbon arcs with the maintenance-free and clean operation of regular discharge or incandescent lamps. The use of high-brightness high-pressure lamps is increasing steadily as more new types of optical equipment are designed and manufactured, which are based on the lamps' favorable properties. They are available in a wide range of wattages between 75 watts and several kilowatts.

The internal operating pressure of these lamps amounts at least to several times atmospheric pressure and may reach 75 atmospheres (1100 pounds per square inch). Therefore, their bulbs have to withstand considerable tensile stresses. In addition, the bulb wall is subjected during lamp operation to substantial thermal stresses resulting from temperature differences. These tensile and thermal stresses present relatively new and unfamiliar problems to the design and production engineer. It is the purpose of this paper to show how the stress components and their distribution within the bulb wall can be calculated. It is further discussed how approximate knowledge of the stress distribution can be utilized for obtaining optimum lamp designs and for estimating the practical feasibility of new lamp types.

Calculation of Tensile and Thermal Stress Components

The theories of elasticity and strength of materials supply basic equations for determining the distribution of tensile and thermal stresses within the wall of vessels under internal pressure at elevated temperatures. These equations were adapted to the conditions and parameters of the quartz envelopes of high pressure lamps and are given for cylindrical and spherical bulb shape.

The tensile stresses are directly proportional to the internal pressure and otherwise depend only upon the bulb dimensions. They are independent of the bulb material properties. The thermal stresses are directly proportional to the amount of heat conducted through the bulb wall. Thus, the bulb surface loading has the same linear influence on the thermal stresses as the internal pressure has on the tensile stresses. The thermal stresses further depend linearly upon material constants, as the thermal expansion coefficient and the heat conductivity of the bulb material.

The actual amount and distribution of stresses in existing lamp types is demonstrated by practical examples. Fig. 2 shows all stress components within the wall of a spherical 75-watt short arc lamp with an operating pressure $P = 60$ atm. and a bulb surface loading $W_s = 25$ watt/cm^2. The tangential component of the tensile stress $\sigma_{p\vartheta}$ is the largest and amounts to nearly 1400 psi at the inner wall. It decreases across the wall to

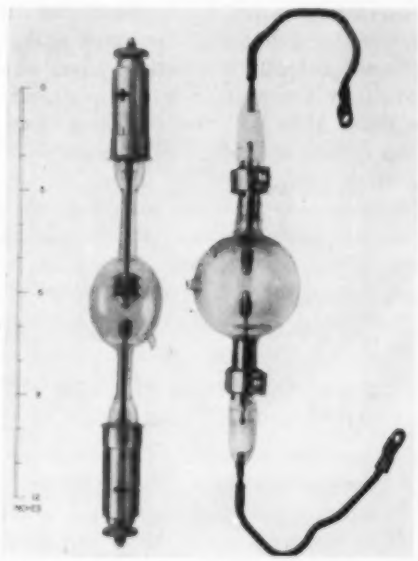


Figure 1. Typical large wattage short arc high-pressure lamps. Left: 1800-watt xenon lamp. Right: 2500-watt mercury or mercury-xenon lamp.

AUTHOR: Duro-Test Corp., North Bergen, N. J.

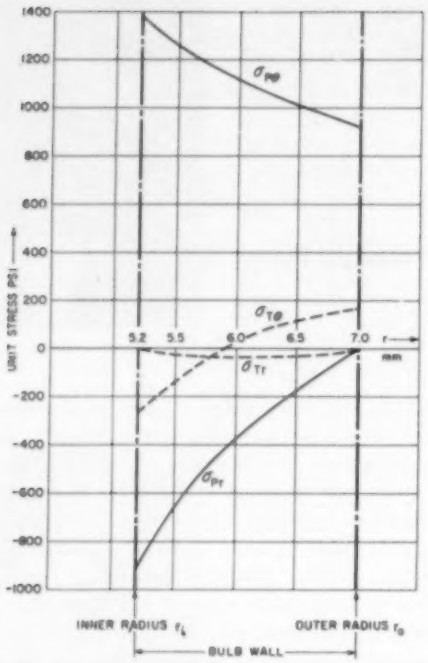


Figure 2. Tensile and thermal stress distribution within the bulb wall of a small spherical short-arc lamp. Inner radius r_i = 5.2 mm, outer radius r_o = 7 mm. Lamp wattage W_L = 75 watts, operating pressure P = 60 atm = 880 psi, bulb surface loading W_s = 25 watts/cm² = 160 watts/in.²

about 900 psi at the outer radius. The tangential component of the thermal stress $\sigma_{T\vartheta}$ is negative at the inner wall indicating compressive stress. It passes through a neutral zone and turns into a tensile stress of 170 psi at the outer radius. $\sigma_{P\vartheta} + \sigma_{T\vartheta}$ together result in a tensile stress which is approximately constant across the wall, amounting to about 1100 psi. Such uniform stress distribution is most desirable from the point of view of material utilization. In theory, it can be achieved best when tensile and thermal stress components contribute approximately equal amounts to the total stress. The radial components σ_{Pr} and σ_{Tr} are compressive stresses of negligable amounts which disappear both at the outer wall.

Theoretical Strength of Lamp Envelopes and Practical Strength of Complete Lamps

The theoretical strength of a lamp envelope can be characterized by a "safety factor." In order to judge the theoretical strength of a given lamp, it is necessary to compute the maximum stress that should actually occur in the envelope according to the given equations and curves and to determine the safety factor. The result is to be compared with the safety factor of other existing lamp types that are known to be reliable in operation.

The practical strength of a complete high-pressure lamp with sealed-in electrodes and leads may be substantially lower than the theoretical strength of the ideally shaped bulb determined by calculation. Certain deviations from the ideal form of the envelope are unavoidable and may cause a concentration of stresses at particular points, *e.g.* at the seals and at the exhaust tubulation. Inhomogeneities in the material, especially bubbles in the quartz, surface scratches, and thermal stresses remaining from the manufacturing processes are other reasons for reduced practical strength of a given lamp design. The actual ability of a lamp to withstand a given internal pressure has to be determined experimentally by subjecting it to a pressure test.

Estimating the Feasibility of New Designs

The practical design possibilities of certain types of high-brightness lamps, especially of the water- or air-cooled capillary type, have proved to be very limited. However, it was difficult to understand clearly the reasons for these limitations. They can be explained satisfactorily on the basis of the particular stress condition in the bulb wall of such lamps. The allowable maximum stress is surpassed in capillary type lamps, as soon as the inner tube radius is essentially increased in order to sustain higher wattages per unit arc length without an increase in bulb surface loading.

As another practical application of the stress calculations, the suitability of synthetic sapphire for the envelopes of high brightness lamps is discussed. Synthetic crystalline sapphire has been suggested occasionally as an improvement over fused quartz, because of its greater ability to withstand high operating temperatures. It seems of interest to examine the properties of sapphire with respect to the size of the thermal stresses to be expected in a lamp envelope mode of this material. One finds that the thermal stresses in a sapphire lamp envelope will amount to approximately 5 times the stresses generated in a quartz envelope under equal conditions. However, the ultimate tensile strength of sapphire seems to be 3 to 4.5 times greater than that of quartz. Thus, there is a good possibility that sapphire lamp envelopes could sustain approximately the same amount of thermal stress as quartz envelopes can hold.

(Abstract of IES Conference Paper No. 16.)

Left to right:

E. C. Martt
K. Gottschalk
A. C. Green

Design Requirements for

High Lumen Maintenance and Easy Starting of Mercury Lamps

LUMEN depreciation of a relatively short arc tube is largely due to end blackening of the arc chambers. This end blackening is caused by the gradual evaporation of the electrode material and the deposit of this material on the ends of the tube. Improvement in electrode design, by reducing the amount and/or type of evaporated material can result in a major increase in lamp lumens.

The most common electrode type used in this country is the thorium-tungsten electrode. This electrode is prone to transfer dense black metallic deposits onto the inside of the arc tube walls during starting and operating. It is, however, relatively inexpensive to make, and its development in 1939 made the high-efficiency quartz arc tube practical.

In Europe, a variety of oxide-electrode designs have been developed. These use barium, strontium, and calcium as the primary emitters, and such materials have a lower work function than thorium. The Osram Company of Germany has developed an oxide-type electrode which gives excellent performance, and this general form has been adopted here. While this electrode is considerably more expensive than the thorium-tungsten electrode, it is practical to make, lumen maintenance performance is excellent, and the starting voltage is low.

The comparison of lumen maintenance during life for both types of electrodes is shown in Fig. 1. The improved oxide electrode lumen maintenance is obviously superior. Table I compares lumen values during life for the two types of electrodes: Over a period of 9000 hours, the improved electrode lamp yields 28 per cent more mean lumens, and at 9000 hours the improved electrode gives 74 per cent more lumens.

One of the design factors which affects both lumen output and starting voltage of mercury arc tubes is the argon filling pressure in the arc tube.

AUTHORS: General Electric Co., Cleveland, Ohio.

TABLE I

	100 Hour Lumens	9000 Hour Lumens	9000 Hour Life Mean Lumens
Thorium Electrodes	21,000 (100%)	10,000 (100%)	14,500 (100%)
Improved Oxide Electrodes	20,500 (97.5%)	17,600 (174%)	18,600 (128%)

TABLE II—Minimum Starting Voltage Requirements

	−20F	0F	50F
Improved Oxide Electrode (H33)	225	210	200*
Thorium Electrode (H1) Present ASA value	290	265	200*
Thorium Electrode (H1), New value	265	240	200*

* Although the arc will strike at a lower open circuit voltage, at least 200 volts are required for stable operation on a reference ballast.

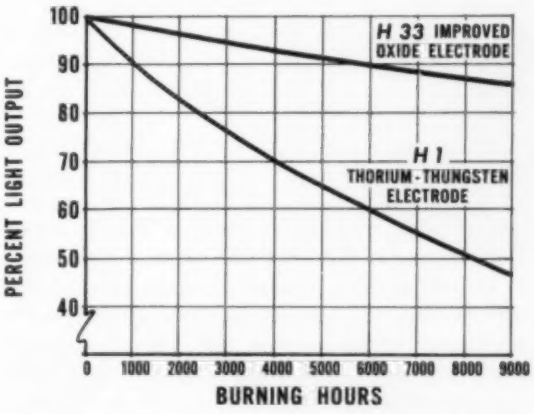


Figure 1. Lumen depreciation comparison of clear H33-1 400-watt lamps with improved-oxide electrodes and H1 thorium-tungsten electrodes. Vertical burning, five hours per start.

Higher filling pressures promote high lumen maintenance by limiting arc tube end discoloration. However, decreased filling pressures reduce the voltage requirements for low temperature starting. The effect of argon filling pressure on starting at 50 degrees, 0 degree and −20 degrees F has been determined for both types of electrodes, and its effect on lumen maintenance has been found for lamps with thorium-tungsten electrodes. Similar tests are under way for lamps with improved oxide electrodes. As a result of these tests, starting data consistent with good lumen maintenance are shown in Table II.

The lower starting voltage for oxide electrodes at low temperatures is very significant, since it is only slightly more than the voltage required for lamp stability. Coupled with the excellent lumen maintenance, lamps with the new improved oxide electrode should open new markets for mercury lamps.

(Abstract of IES Conference Paper No. 37.)

Improvements in Fluorescent Lamp Efficiency Resulting from Particle Size Control of Phosphors

K. H. Butler

H. H. Homer

THE NECESSITY of milling fluorescent phosphors to achieve the desired coating texture has long been a troublesome problem, since it has usually resulted in a loss in lumen output. Many explanations have been proposed for this loss, without achieving any practical method for eliminating it. This paper proposes a theory, based on relating the efficiency of fluorescent lamps to the optical properties of the phosphor coating, which has resulted in the development of a method of substantially reducing the lumen loss.

Mathematical calculations have been carried out which show that the major controlling factor in lumen efficiency is the reflection of ultraviolet energy from the phosphor back into the arc stream. The amount of this reflection is dependent on phosphor particle size and is determined by a scattering constant, β, whose value is determined by the particle size distribution of the phosphor.

Reflectance measurements on phosphors of various particle sizes confirm the predictions from the mathematic calculations. Comparison of the data with the predictions indicates that the scattering of energy falling on the phosphor is directly dependent upon phosphor particle size. The smaller the particle size, the greater is the scattering effect, β, and therefore the greater the loss of ultraviolet energy. In effect, the smaller the phosphor particle size the lower the lamp efficiency will be.

Tests carried out in lamps indicate that phosphor particles below 3μ present in the phosphor as received, or produced by mechanical reduction of oversized particles to achieve proper coating characteristics, lower the lumen output of the lamps. Removal of both the oversized and the less-than-3μ particles leads to improved β values and yields higher lumen outputs with improved maintenance. This has made possible the production of 74 lpw 40-watt white lamps.

In addition, use of the finding that phosphors of different β values require different coating transmissions for optimum lumen output has given further gains and has led to efficiencies of 75-80 lpw. These gains have been accomplished by changes in phosphor and coating alone. If, at the same time, changes are made in the lamp arc parameters, the output of 40-watt white lamps has been increased to 80-85 lpw.

(Abstract of IES Conference Paper No. 14.)

AUTHORS: Sylvania Lighting Products, Salem, Mass.

Wilfrid G. Matheson

Rhenium as an Incandescent Source

THIS PAPER reviews the history of rhenium since its discovery with references to its availability from known deposits and the present cost of rhenium wire as an incandescent light source. Characteristics of the metal rhenium are pointed out and compared with those of tungsten. The accompanying tables give some of the important physical characteristics: corrosion resistance, mechanical properties of rhenium wire and the mutual solubility of rhenium with other metals.

AUTHOR: Sylvania Lighting Products, Salem, Mass.

TABLE I — Some Properties of Rhenium and Tungsten.

	Rhenium	Tungsten
Atomic number	75	74
Atomic weight	186.31	183.92
Density	21.04	19.3
Melting point	3180 ± 20C	3380 ± 20C
Boiling point (760 mm Hg)	5900C	5930C
Vapor pressure at 2500C	5.0×10^{-6} mm Hg	4.3×10^{-6} mm Hg
Vapor pressure at 3000C	5.6×10^{-5} mm Hg	8.5×10^{-4} mm Hg
Resistivity, micro ohm cm 20C	19.21	5.64
Linear coefficient of expansion 0-1000C	6.8×10^{-6}/°C	$4.6\text{-}5.2 \times 10^{-6}$/°C
Spectral emissivity 1200-3000C	.430 – .360	.450 – .410
Thermonic Emissivity		
Richardson constant	52 Amp./cm²/°K²	70 Amp./cm²/°K²
Work function	4.80 e.v.	4.55 e.v.

Photomicrographs of the recrystallized wire are included in the paper. Curves showing the resistivity, spectral emissivity, vapor pressure, evaporation rate, black-body temperature compared with tungsten are included. In summary, it is pointed out that the metal working and wire drawing techniques are difficult and expensive. Further research and development are necessary to produce satisfactory filament wire. Credit is given to many of the principal investigators and these references are listed.

(Abstract of IES Conference Paper No. 36.)

Problems and Progress In Electroluminescent Lamps

Henry F. Ivey

THIS PAPER describes some of the present applications of electroluminescence and some of the problems in selection of materials and in lamp design which are met in the fabrication of lamps for these applications.

The particle size of the phosphor used has an important effect on lamp performance. Use of small particles leads to a steeper "slope" for the brightness-voltage characteristic and to higher efficiency, but to poorer maintenance of output than with large phosphor particles.

The maintenance of output of electroluminescent lamps is discussed generally. The total number of cycles of alternating voltage to which the lamp has been subjected (the product of frequency and time) is the important determining factor for maintenance, rather than frequency or time alone. It is found experimentally that the regions of the phosphor which suffer deterioration are more localized at low voltages and at high frequency. This leads to several interesting

AUTHOR: Westinghouse Electric Corp., Bloomfield, N. J.

facts. Operation at high voltage and low frequency following operation at low voltage and high frequency can result in a maintenance characteristic unaffected by the first mode of operation. In this way, "two lifetimes" may be realized. The same localization effect results in better maintenance for constant brightness (variable voltage) operation than for constant voltage operation. Since the decrease in light output during life is accompanied by an increase in impedance of the lamp, the observed maintenance characteristic can be improved by connecting an external impedance in series with the lamp.

The electrical resistance of the transparent electrode used in lamp construction can affect the uniformity of emission over the emitting area, the efficiency, and the measured electrical properties of the lamp. Such effects are greater the higher the electrode resistance, the larger the lamp, and the higher the frequency.

Electroluminescent lamps with sub-divided electrodes for display of numerical or alphabetical information will be described. An optical effect concerning the variation in brightness near the boundary between illuminated and non-illuminated areas in such lamps will be discussed.

A variety of different types of electroluminescent lamp construction is reviewed, including the use of thin continuous phosphor films instead of phosphor powders embedded in an organic or inorganic dielectric medium.

(Abstract of IES Conference Paper No. 13.)

Significant Advances in the Design Of Non-Circular Cross-Section F-Lamps

J. O. Aicher

E. Lemmers

THE NON-CIRCULAR cross-section, highly-loaded fluorescent lamp, introduced in April, 1956, has been widely accepted because it combines the desirable qualities of lumen output and efficacy with long life.

Several new concepts made possible by a non-circular cross-section have enabled the lamp to be significantly improved. The new lamp operates on present 1500 ma ballasts and produces a 15 per cent increase in light output along with an 8 per cent increase in efficacy. The improved lamp is also made in a T17 bulb but with grooves on both sides, the grooves being shorter and more numerous. The modified geometry has made it possible to use a thinner bulb wall so that the lamp's weight has been reduced by 25 per cent without sacrifice of strength. Lamp loading and efficacy have been increased by the elimination of zones of round cross section, where wattage expenditure and efficacy of light production are low. The grooves of the new lamp are less deep and more open, permitting better utilization of the coated area of the bulb and allowing more light to escape directly, further improving lumen output and efficacy.

As with all highly-loaded fluorescent lamps, to obtain maximum wattage loading with minimum lamp current and starting voltage, mercury vapor pressure must be controlled. This has been accomplished by providing one groove on each side, near the center of the lamp, having an asymmetric cross section so that the arc avoids a portion of the bulb. This area is cooled by natural convection and operates at 40C. These mercury control areas are hardly noticeable. In making precision measurements all liquid mercury must be located in the coolest part of the bulb. Visual observation of mercury distribution is not satisfactory for determination of the fulfillment of this condition. A very satisfactory procedure for determining completeness of stabilization is described, based on cooling the condensed mercury area for a short time.

When stabilized, the 96-inch lamp in a hori-

AUTHORS: General Electric Co., Cleveland, Ohio.

zontal position with grooves sidewise, and operating at 1.5 ampere (linear choke) under industry-standard conditions of still air of 77F consumes 215 watts and produces 15,000 lumens at an efficacy of 70 lumens per watt. Not stabilized, or over a rather wide range of (indoor) temperatures, its light output and efficacy are at least 95 per cent of the rated value. Operation with grooves up and down derates the lamp approximately 5 per cent.

Three lengths of lamps are available, 96, 72 and 48-inch. All are of the rapid-start type and available at present in the standard cool white color. Light distribution is bi-directional, similar to that of the original lamp. Basing is the same as the previous design. In new fixtures the lampholders should be positioned to give the best performance considering the output of the lamp-luminaire combination.

(Abstract of IES Conference Paper No. 15.)

Factors Influencing the Design of Extra Output Circular Cross-Section F-Lamps

C. J. Bernier

RAPID acceptance of the high brightness fluorescent light sources, introduced within the last three years, indicates a promising future for lamps designed to operate at relatively heavy loadings. This paper deals with some of the factors which influence the design of circular cross-section T12 lamps which operate at loadings of 25 watts or more per foot of lamp length.

The efficiency of generation of 2537A radiation in the positive column can be enhanced by increasing the average energy of the electrons, *i.e.*, by increasing the electron temperature. The over-all efficiency of the lamp can also be increased by raising the voltage gradient of the positive column and thereby allowing more energy to be put into the arc at a given current. The use of neon or helium as a principal fill gas will perform both of these functions. The choice of fill gas depends on the level of loading desired. Partial pressures of helium or neon in argon have been used in the heavily loaded 25-watt-per-foot lamp and the effects of these gas mixtures on lamp parameters are discussed.

AUTHOR: Sylvania Lighting Products, Danvers, Mass.

TABLE I.

Lamp	Loading Watts per foot	Surface Brightness Footlamberts
48-inch T12 high-output	15	3400
Heavily loaded	25	5000
Heavily loaded, 135° reflector coated	25	6400
Heavily loaded, 235° reflector coated	25	8000
T12 experimental	50	9000

Of particular interest is the effect of mixed gases on lumen maintenance. Curves of lumen maintenance for neon-argon and helium-argon lamps at loadings of 25 watts per foot and 50 watts per foot (experimental lamp) are shown in Fig. 1. The

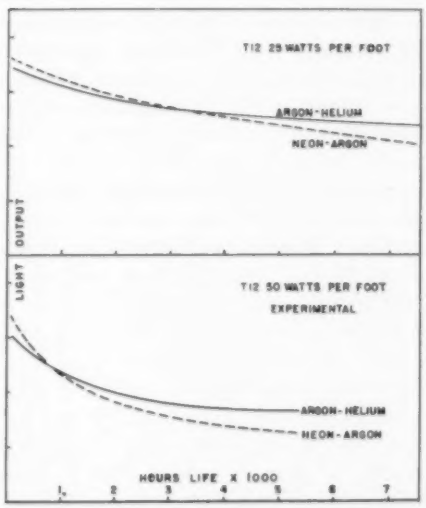


Figure 1. Lumen maintenance curves for T12 lamps filled with argon-helium and with neon-argon, operated at loadings of 25 watts per foot and 50 watts per foot.

helium-argon lamp gives a 7 per cent increase in "mean lumens" over that for neon-argon for 7500 hours of life at 25 watts per foot and the margin is much greater at loadings of 50 watts per foot.

The heavily loaded 25-watt-per-foot lamp has created a new interest in controlling light distribution by means of reflectors. In applications where it is desirable to project a pattern of uniform light to maximum distances the uniform T12 source is most practical. Table I shows some of the brightness levels achieved with lamps designed for use in controlled fluorescent reflector fixtures where design for uniformity is possible with a single circular cross-section lamp and is more effective than designs utilizing several lamps packed together. Such lamps are particularly suited for such applications as floodlighting, street and runway lighting, service stations and building face lighting and for special applications such as photocopying.

(Abstract of IES Conference Paper No. 21.)

John H. Campbell

New Parameters for High Frequency Lighting Systems

THIS PAPER is intended as a progress report for the planners of fluorescent lighting installations who in the near future may have the necessary equipment to provide the lighting advantages illustrated by recent laboratory developments.

Lamp characteristic data obtained over the past 12 years have clearly shown that fluorescent lamp characteristics improve with increased frequency to at least 20,000 cycles. Factors such as higher lamp and system efficiency as well as smaller and lighter weight ballasts provide over-all advantages which have resulted in a number of outstanding high-frequency installations in recent years. The power supply frequency has been limited by economics to 360, 420 and 840 cycles. Even at these frequencies the over-all cost of light is generally lower than the 60-cycle system for industrial and commercial applications of 50 kilowatts or more.

AUTHOR: General Electric Co., Cleveland, Ohio.

Frequency

With the introduction of semiconductors capable of switching several amperes at high repetition rates, the lighting industry now has the opportunity to provide fluorescent lamps with a-c power in the range of 1,000 to 10,000 cycles. The feasibility of generating higher frequencies for fluorescent lighting has opened up additional investigations in the development of lamps and systems. A new set of parameters involving power supplies, ballast circuits, and lamp characteristics has unfolded.

The optimum frequency will depend largely upon the location of the power supply. With present knowledge of the art, it appears that high-frequency power systems may take three forms to cover various sizes of installations with suggested maximum frequencies as follows:

(1) Integral power supply (10,000 cycles)

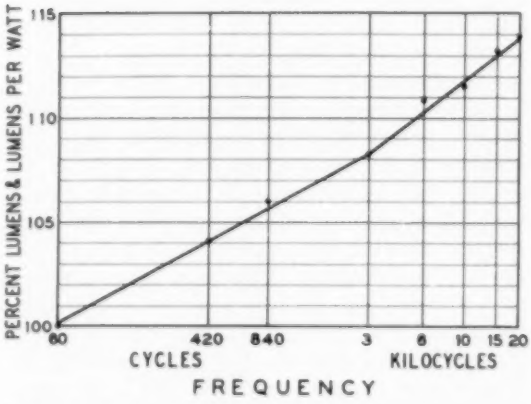


Figure 1. Per cent increase in lumens and lumens per watt with increase in power frequency. Curve represents average of ten 40-watt argon-neon T3 lamps. Lamp watts were held constant at 40 watts over the entire frequency range.

Figure 2. Cleveland Transit System bus equipped with experimental transistor inverter providing 3000 cycles for 42-inch T6 slimline lamps. The 16 lamps are operated on 8 two-lamp ballasts weighing only ¾ pound each. Lighting levels range from 25 to 35 footcandles. By contrast, the filament lighting system measured from 4 to 12 footcandles.

(2) Branch circuit power supply (3,000 cycles)
(3) Central power supply (1,000 cycles)

The *integral power supply* of 1 to 5 kilowatts capacity would be located at a point near a group of fixtures or spaced to be in the center of a luminous ceiling. Due to the short distance from power supply to load, an output frequency such as 10,000 cycles could be employed without excessive losses in the wiring.

The *branch circuit supply* might be located in a panel box in the hallway. Power supplies at branch lighting circuits could provide up to 10 kilowatts each at 3,000 cycles. This allows for a de-rating factor of 12 per cent to permit distribution of 3,000 cycles on 60-cycle wiring.

A *central power supply* may provide the lowest cost per kw for large industrial and commercial installations. In such installations the comparatively long runs from power supply to the load will probably limit the maximum frequency to 1,000 cycles.

Figure 3. At the right is the 20-pound transistor inverter. At the left foreground are the 8 two-lamp 3000-cycle ballasts stacked next to the same number of 60-cycle two-lamp ballasts. Not shown is the 60-cycle inverter which would be required if the bus had been equipped with the conventional ballasts at the left background.

Lamp Characteristics at High Frequency

The recent improvement in lumen output and efficacy of 40-watt lamps for conventional 60-cycle systems has resulted in proportionately greater gains at higher frequencies. Fig. 1 illustrates this characteristic. A 3100-lumen 40-watt lamp at 60 cycles would have ratings of 3300, 3350, and 3450 for 1,000, 3,000 and 10,000 cycles respectively. At 60 cycles the lumens per watt are 77 but increase to 82, 84 and 86 respectively at the corresponding higher frequencies.

Semiconductor Power Supplies for F-Lamps

In the process of investigating the new possibilities of the high-frequency lighting systems, a power transistor inverter was developed. This prototype power supply has been in operation since April 1959 in a Cleveland Transit System bus (Fig. 2). In addition to providing over three times the lighting level of filament-lighted buses, this unit is being tested to determine transistor and other component reliability for possible use in general lighting. An over-all efficiency of 88 per cent is obtained in supplying power to 16 42-inch T6

slimline lamps. Fig. 3 shows the 3,000-cycle power supply and ballasts compared to the conventional 60-cycle ballasts normally used for the 42-inch T6 lamp in other applications.

Controlled rectifiers and power transistors are becoming available at higher voltages, and circuits similar to that of the bus inverter are being tested for use in general lighting. It is expected that these power supplies will provide input to lamp terminal efficiencies in excess of 90 per cent with a total weight of less than 10 pounds per kilowatt.

(Abstract of IES Conference Paper No. 38.)

E. G. Zubler

F. A. Mosby

An Iodine Incandescent Lamp with Virtually 100% Lumen Maintenance

IODINE is being used in tubular, incandescent lamps in a regenerative process to prevent blackening and enhance life by redepositing evaporated tungsten (W) on the filament. During normal operation of an incandescent lamp, W is transferred from the filament to the wall either by evaporation and diffusion or via the water cycle, resulting in blackening. Iodine atoms (I) produced by the pyrolysis of molecular iodine (I_2) in the vicinity of the filament diffuse to the wall and under the proper conditions react with the absorbed W, forming a volatile tungsten di-iodide, WI_2 which diffuses to the filament. The WI_2 is decomposed on the filament resulting in the deposition of the W on the filament surface and the production of I atoms which then repeat the cycle.

Consequently, the iodine cycle depends on the reaction:

$$W + 2I \leftrightarrows WI_2$$

where the forward reaction predominates at the wall while the reverse reaction predominates at the higher temperatures of the filament. WI_2 may also be formed in the gas phase as a result of a reaction between gaseous W and I atoms (or I_2) with an inert gas, *e.g.*, argon (Ar) removing the excess energy.

The iodine cycle has been extensively studied in the developmental lamp shown in Fig. 1. This particular lamp is a nominal 500-watt, 120-volt lamp containing 600mm of Ar and approximately 1μ mole of I_2. With the successful operation of the iodine cycle, the development lamps showed no blackening during operation with filament temperatures of approximately 3000K and most lamps had 100 per cent lumen maintenance.

Iodine lamps have been operated successfully with bulb wall temperatures in the range 250–1200C, I_2 concentration in the range 0.01–1.0μ moles and inert gas (argon, krypton, xenon and nitrogen) pressures in the range 600–6000 mm.

Some of the developmental iodine lamps ranging from 1⅝ to 10 inches in length and from 5/16 to ½ inch in diameter are shown in Fig. 2. Operating voltages are 120 volts or less with the exception of the 1500-watt lamp which operates at 277 volts.

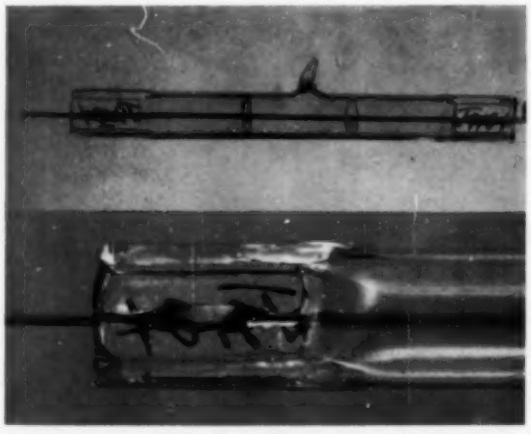


Figure 1. A 500-watt quartz iodine lamp and an enlargment of the pinch seal.

AUTHORS: General Electric Co., Cleveland, Ohio.

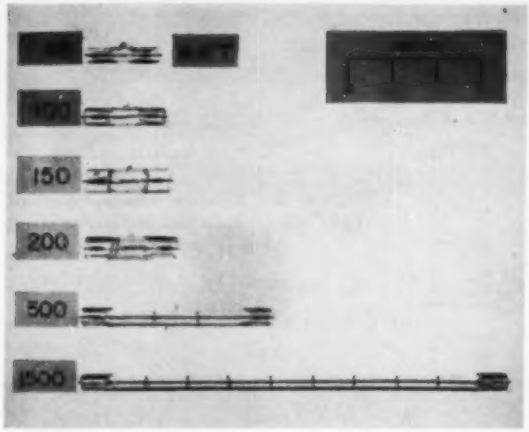


Figure 2. Developmental quartz iodine lamps.

The iodine lamp as designed, in comparison with the presently made incandescent lamp of equal wattage, offers an incandescent light source that is drastically reduced in size, with efficacy ratings independent of fill gas pressure, whose total lumen output can be increased while maintaining equal life, can be operated at higher voltages and which maintains 96–101 per cent lumen output until burnout. Present applications include airport runway illumination, wing tip marker on high speed aircraft and as a high intensity source of radiation for growing algae in underwater and space travel research. Possible applications include street lighting, floodlighting (outdoor and indoor), display window lighting, and illumination for movie and television studios.

(Abstract of IES Conference Paper No. 19.)

W. S. Till

M. C. Unglert

New Designs Revitalize Mercury Lamps And Increase Their Usefulness

RECENTLY some very important improvements have been achieved in the design of quartz mercury lamps. A new electrode design, together with a new type of oxide emission material, has permitted greatly increased lumen maintenance in such lamps, giving them the best maintained light output throughout the life of any vapor lamp including fluorescent lamps. At the same time it has provided much easier starting especially during cold temperatures. Because of this, the American Standards Association—recognizing the significant lowering of starting voltage requirements of this new type of lamp—has assigned the characteristic number "33" to designate lamps of the 400-watt size having this electrode. In addition to the development of the new electrode, there have been other improvements affecting almost all types of mercury lamps. These include better methods of

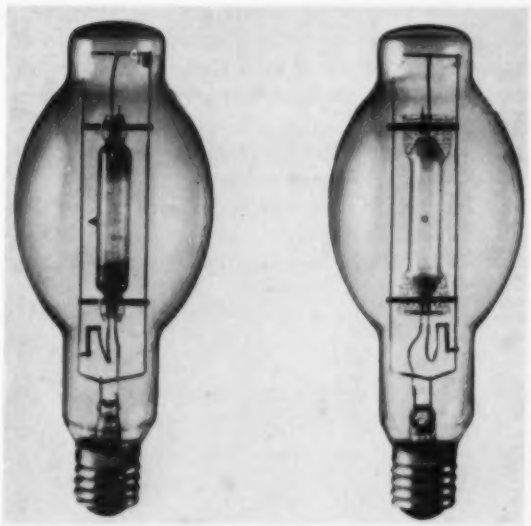


Figure 1. Left, 4000-watt H1 mercury lamp after 7000 hours' burning. Right, 400-watt H33 mercury lamp after same number of hours' operation under same conditions. Note reduction in blackening of the arc tube.

AUTHOR: Westinghouse Electric Corp., Bloomfield, N. J.

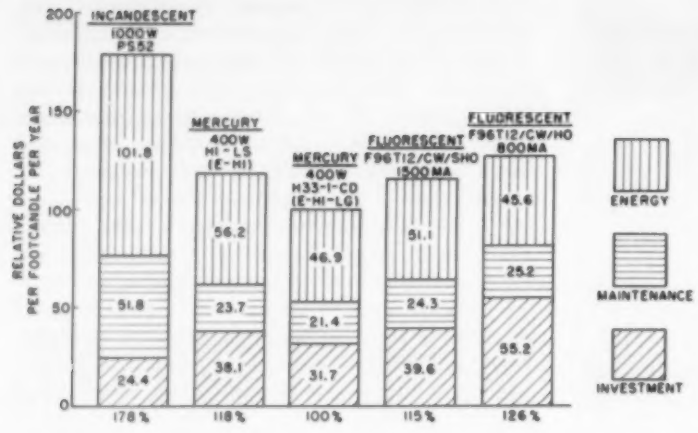


Figure 2. Relative annual cost of light for a high-bay industrial area, type "A" room.

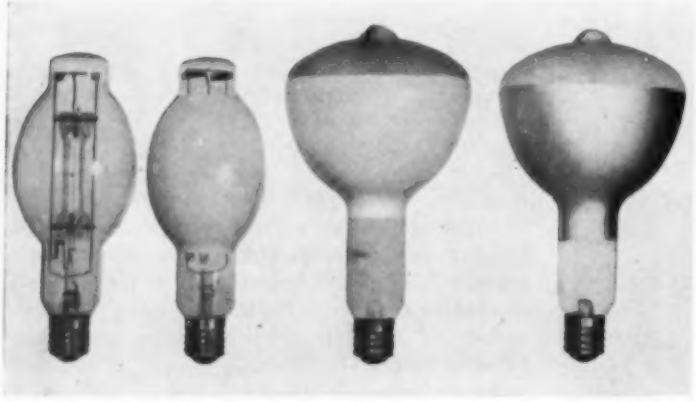


Figure 3. 400-watt H33 mercury lamps of improved design. Left to right: H33-1CD; H33-1GL/C, W or X; H33-1DN/C, W or X; H33-1FY or HS.

sealing the ends of the quartz are tube, simplification of are tube support structure, new types of resistors, greater use of hard glass outer envelopes, improvements in the base, and several other design changes.

Use of the new electrode, together with the other improvements, has resulted in the publication of much longer life ratings. For instance, the regular H1LS (E-H1) mercury lamp has been rated in the order of 6000-7000 hours economic life, whereas the newly designed comparable H33–1CD lamp is now rated at 9000 hours economic life. The average life to burn-out for both types is, of course, much longer than this. The increased economic life rating for these new lamps is supported by cost studies which show that the new design saves approximately 18 per cent in annual cost of light depending upon the type of installation.

(Abstract of IES Conference Paper No. 35.)

Photometry

A New Method for

Studying the Effects of Direct Sunlight on Building Interiors And Subsequent Skylight Studies

Ben H. Evans

Matthew A. Nowak

THE FEASIBILITY of using models for the study of natural lighting has been well established by researchers around the world in the past 25 years. However, for the most part, these model studies have been limited to overcast sky conditions due to the complicacy of studying with both a simulated sky and simulated sun. This paper describes the development of a new method for studying natural lighting with a simulated sun.

New Method

The new method involves the use of scale models, a simulated sky and a simulated sun. The simulated sky is a flattened hemispherical dome, illuminated by 150-watt incandescent floodlamps suspended in a trough around the base of the dome. The simulated sun consists of an easily portable incandescent 5000-watt spot lamp, used in conjunction with an eight-foot square terrain table (Fig. 2). The lamp is used at a distance of 20 to 40 feet from the terrain table, depending on the area of light desired on the table top and the footcandle level desired.

Because of a limited laboratory space and ceiling height, the sun lamp is used in a horizontal position, projecting its light laterally across the laboratory to the terrain table. The table adjusts to provide any sun angle. Surface reflectance is provided to represent whatever ground conditions are involved in the full-scale counterpart. To eliminate stray and reflected light from confusing the model test results, the area around the terrain table is screened with heavy black curtains and ceiling baffles. The laboratory is darkened as much as possible during tests.

Again, because of the physical and economic limitations of the laboratory room, the sun lamp and sky dome are not used simultaneously. Tests on any given model are first conducted in the lighting dome and then on the terrain table under the sun lamp. The results of these two separate tests are related by calculation to full-scale conditions and added together for the final results.

Performance of Sun Lamp

The sun lamp is of a commercial type, readily available on the open market. It has complete control for focus, shutter, angle, and size and shape of spot. It is mounted on wheels and has a counter-

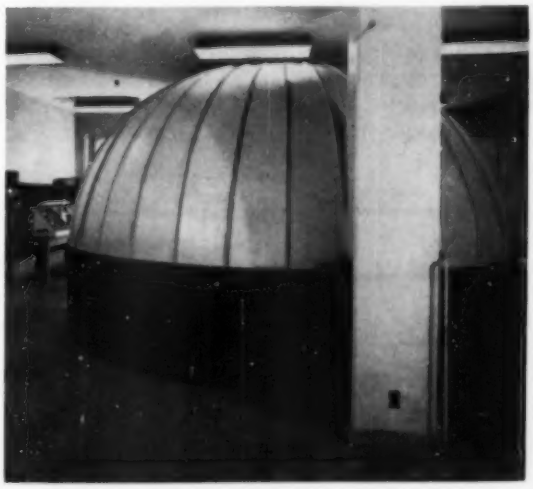


Figure 1. Simulated sky dome.

AUTHORS: Texas Engineering Experiment Station, College Station, Texas.

Figure 2. The electric sun lamp and terrain table.

balanced height adjustment. Near parallel light rays are produced with the aid of a built-in reflector and a Fresnel lens.

At a distance of 40 feet, the sun lamp produces an average intensity of about 160 footcandles on the terrain table top. While the pattern is not entirely uniform over the table surface, it has been found to be sufficiently uniform to produce satisfactory results.

In order to establish the value of model studies with the sun lamp, a model of a typical classroom was constructed. This model included three plastic dome skylights and a fenestration of typical construction with no blinds or sun controls. The model was first tested in the field under a clear sky with direct sunshine. It was then tested under the simulated sky in the laboratory using a standard clear sky brightness distribution. Next the model was moved to the terrain table and tested under the sun lamp. Results of the tests under the simulated sky and sun lamp were then related to actual full-scale sky conditions and added together to provide the final results.

Fig. 3 shows the resulting intensities when the model was tested under actual sun and clear sky (top line of chart) and under the simulated sky dome and sun lamp (second line of chart). The average error is less than two per cent and the maximum error only slightly over six per cent.

The amazing accuracy of these results to date indicates the real feasibility of performing studies with the laboratory equipment described here.

Conclusions

Predetermination of the natural lighting conditions inside buildings through the use of models tested under a simulated sky and sun is now possible and extremely feasible. Any building, regardless of size, shape or design, can be accurately and economically analyzed under any sky conditions—overcast, partly cloudy or clear with sunshine. No longer do architects have to guess at natural lighting conditions for their imaginative and nonconforming buildings. No longer do they have to "try-it-and-see" to determine the effects of various new design schemes. Now they can have complete answers in advance.

(Abstract of I.E.S. Conference Paper No. 8.)

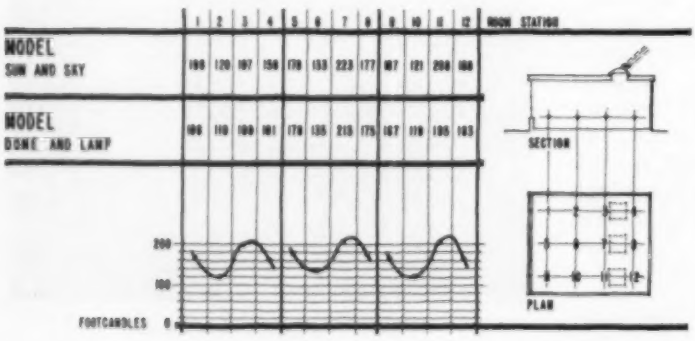


Figure 3. Levels resulting from a study of a model with skylights.

Measuring F-Lamp Characteristics For the Outdoor Environment

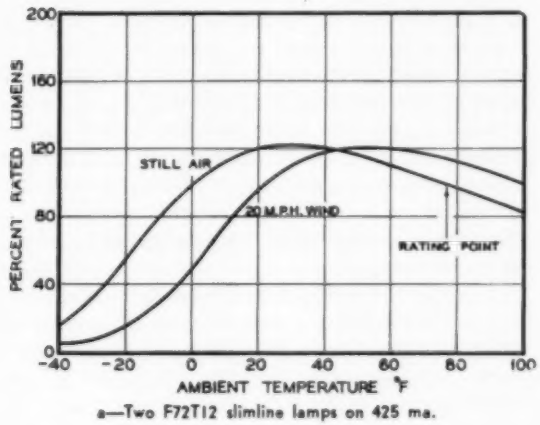
P. R. Herrick

R. E. Wenner

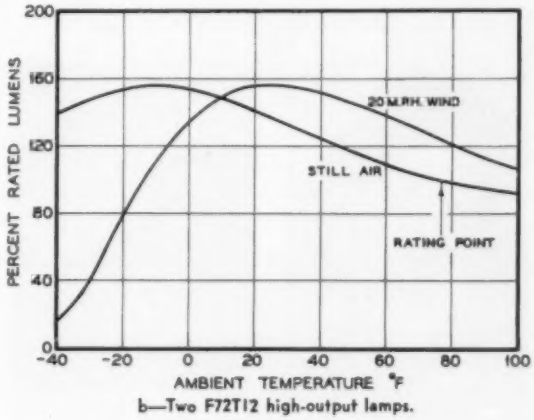
THE DESIGNER must know the effect of temperature and wind on the performance of a fluorescent lamp luminaire in order to prediet the ilumination it will deliver under outdoor conditions. This paper describes an environmental test chamber for such measurements. This consists of a 10- by 10- by 10-foot room, controllable in temperature from —40F to 100F. The chamber includes a two- by two- by eight-foot wind tunnel, producing winds from three to 25 mph. The chamber is operated on an automated basis to record the effect of a range of ambient temperature and wind conditions upon the light output or other operating characteristics of lamps and luminaires.

To appraise the performance of an outdoor fluorescent lamp luminaire, the designer must have both photometric and environmental data. Typical outdoor conditions are generally more favorable to efficient fluorescent lamp operation in an enclosed outdoor luminaire than in the still air 77F condition under which it is photometered. To form

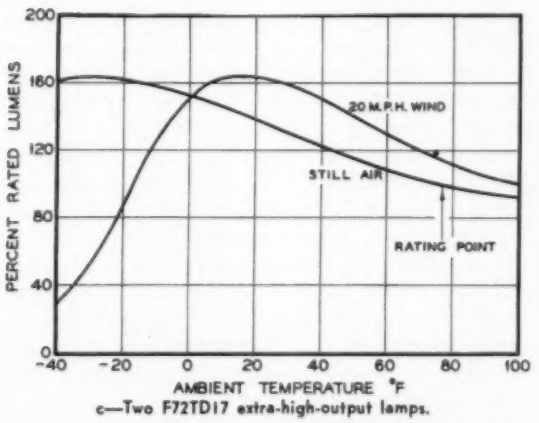
AUTHORS: General Electric Co., Cleveland, Ohio.



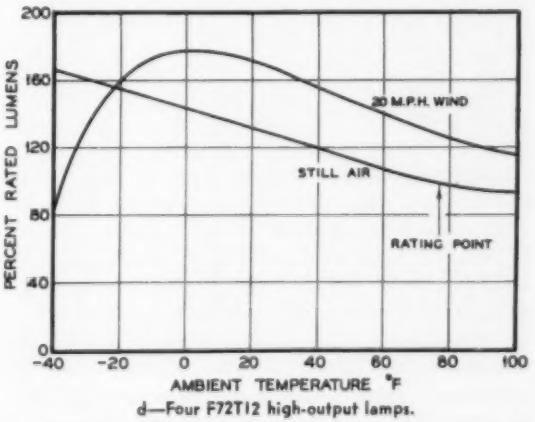
a—Two F72T12 slimline lamps on 425 ma.



b—Two F72T12 high-output lamps.



c—Two F72TD17 extra-high-output lamps.



d—Four F72T12 high-output lamps.

Figure 1. Temperature characteristics of the same fluorescent floodlight with three different lamp types. Each curve is drawn relative to the photometric rating with the particular lamps. That is, for each lamp combination, the light output at 77 degrees, still air, is taken as 100 per cent.

any quantitative judgment of the photometric characteristics of a luminaire, the increase in light output, which will be obtained under cooler and windier outdoor conditions, must be taken into account. In addition, the designer must appraise the variations in light output over a reasonable range of environmental conditions to which the luminaire will be subjected. To aid in this evaluation, a statistical interpretation of weather bureau data is suggested.

Investigations have shown that the shape of the characteristic curve of light output versus ambient temperature is very similar for a number of common fluorescent lamp types. This characteristic is shown in Fig. 1. The curve will be displaced as to ambient temperature by varying amounts depending upon the luminaire construction.

Where environmental testing facilities are not available, an estimate of the outdoor fluctuation in light output due to temperature may be formed on the basis that the characteristics of the luminaire in question will be shaped quite similarly to the curve in Fig. 1. By observing the warm-up characteristic of the luminaire, and recording the fall-off from peak light output with operation at normal room temperatures, the relationship of this curve to ambient temperature for the test luminaire may be determined. A detailed procedure for this estimating technique is given in the paper.

(Abstract of I.E.S. Conference Paper No. 6.)

On the Foundations of Goniophotometry

D. E. Spencer

S. M. Gray

PRESENT goniophotometric procedures are unsatisfactory, from both logical and empirical points of view. Logically, the system of specification should be sufficiently general to cover all types of surfaces from perfectly specular to perfectly diffuse, but even the most recent goniophotometric studies are based on a concept which is not sufficiently general. Empirically, it should be possible to make measurements on a sample which will permit the prediction of its appearance when illuminated by any arrangement of light sources. The prevailing custom is to run off numerous goniophotometric curves without a rigorous analysis of exactly what photometric concept is being measured. Unfortunately, the quantity measured depends on both the characteristics of the sample being tested and on the illuminating and viewing system of the goniophotometer. Such measurements do not allow the prediction of the appearance of the surface under other illuminating and viewing arrangements.

The paper describes a general method of specifying the reflecting and transmitting characteristics of any surface. Two reflectances are required: a *specular reflectance* which is a function of one angle, ρ_S (θ_R), and a *diffuse reflectance* which may depend on three angles, ρ_D $(\theta_R; \theta_S, \psi)$. Likewise, *specular transmittance*, Υ_S (θ_R), and *diffuse transmittance*, Υ_D $(\theta_R; \theta_S, \psi)$ are defined.

Exact procedures for measurement of the specular and diffuse quantities are required. At specular angles, a series of measurements should be made with a uniform light source of variable diameter which (if employed with specularly transmitting or reflecting samples) fills the entire field of view of the receiver. At non-specular angles, a uniform source which is completely excluded from the field of view of the receiver is required. From such measurements, both specular and diffuse reflectance (or transmittance) can be calculated at any angle; the values are characteristic of the surface alone and are independent of the particular measuring instruments. Illustrative examples are given in the paper.

(Abstract of I.E.S. Conference Paper No. 7.)

AUTHORS: University of Connecticut, Storrs, Conn. and Sylvania Lighting Products, Salem, Mass., respectively.

Calculations and Research

Programming the IBM 704 Computer for

Photometric Data Reduction, Documentation and Application

Alfred B. Gough

PHOTOMETRIC data of outdoor lighting luminaires and floodlights are recognized to be an important element in the information system of lamp and lighting equipment manufacturers. Many of the systems now utilize some form of accounting machine or small computer in their general operations. However, the current volume of testing and subsequent computational work requires that plans be made to include a high-speed digital computer as a major component in the information system. In this particular case the IBM 704 Computer with cathode ray tube (CRT) display and recorder is used. Particular care is taken first to acquaint the reader with the capabilities of the computer and the high speed CRT display unit which can plot points at speeds better than 7000 per second. A brief introduction to symbolic programming then leads directly into the programming for floodlight photometric data reduction and system application computations.

The new information system including the IBM 704 was designed to complete all phases of the photometric data reduction for a floodlight. The basic program outlines are described and depicted by means of information flow and logical diagrams. Three steps make up this data reduction program. The first includes the point-by-point calculations to determine candlepower and lumen values. Then interpolation of the candlepower array affords information for the CRT (IBM 740 and 780) display and recording of the isocandle lines. (See Fig. 1) The coordinates for the beam limit isocandle line are stored at the same time and used together with the lumen array to complete the beam efficiency determination. The actual production run with magnetic tape input and output includes the added reliability of three complete isocandle line plots with separate photographs. All three steps including the film frame advancement are program-controlled and completed in just under two minutes.

AUTHOR: General Electric Co., Hendersonville, N. C.

The separate lighting application program combines 80 floodlights into a complete simulated system to determine illumination characteristics for a high school football field. A rectangular coordinate grid system is used to section off the area being illuminated. Floodlight locations and out-

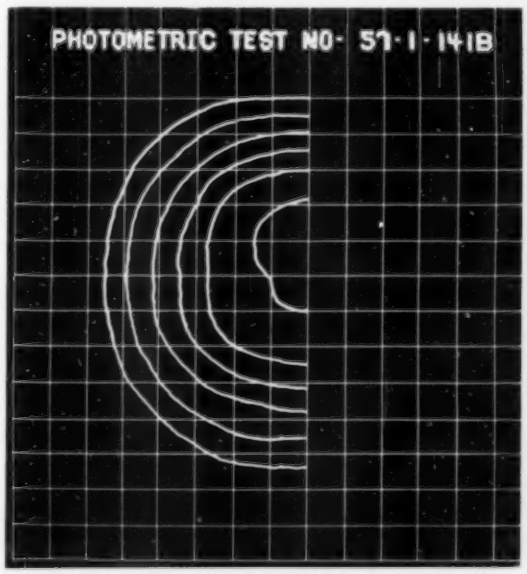


Figure 1. Enlarged print of 35-mm negative from IBM cathode ray tube output recorder. The family of curves and the *X-Y* coordinates represent floodlight isocandle lines and grids spaced at four-degree horizontal and vertical intervals.

put arrays are related mathematically to the area being illuminated and its grid system. Aiming parameters, based on illumination principles and limited by the physical dimensions of mounting, the area to be and not to be illuminated, and other similar restrictions, are then varied in specific manners through a refinement loop until the grid system registers that the preset illumination criterion has been met. At that point the projector aiming angles and illumination levels in each grid are listed in the output.

This illumination calculation program can also be used as a tool in further research on lighting systems. Various parameters such as beam width, mounting height, and numbers of floodlights can be manipulated and their effect on the over-all system evaluated. Certainly the principles developed in this paper can be carried over to other types of general lighting systems as well as to the visibility and seeing evaluation studies now being carried on in the street lighting field.

(Abstract of IES Conference Paper No. 22.)

Use of Computers in Design and Analysis of Luminaires

Bill F. Jones

THE AVAILABILITY of computers capable of solving sizeable matrix equations has created new methods of fixture design and analysis. The luminous analog computer is particular by adaptable to this type of analysis, since it enables the designed to build an electrical "model" of the fixture, which he can then modify as desired to achieve the specified performance.

In theory, accurate results are obtained only for fixtures all of whose surfaces reflect or transmit in a cosine manner. Actually, it is found that considerable variations from this ideal can be tolerated, still achieving results which are well within the bounds of engineering tolerances. Some fixture characteristics are more sensitive than others to departures from cosine-law reflectances; among these is fixture brightness. Others, such as efficiency, are quite insensitive to such deviations, thus broadening the area in which useful information can be obtained.

At the present state of the art, it has been found practical to predict the following performance characteristics to useful tolerances:

(1) Efficiency. This figure is accurate for the broadest range of fixtures. Its usefulness is limited by the fact that the computer will not predict the loss in light output of the lamp due to heat, and therefore calculations for units which do produce a significant amount of such loss must be modified by the known effect of heat.

(2) Upward and downward components. Accurate for any unit which can be evaluated at all by this method.

(3) Fixture brightness. Accurate in detail only for diffuse surfaces, but useful for average brightnesses for most fixture surfaces, such as painted, porcelain, diffusing glass, etc.

(4) Distribution curves. Predictable for fixtures whose surfaces are substantially diffuse; not particularly useful for lenses, louvers, etc. Knowledge of lens' characteristic distribution plus computer-derived lens output makes distributions calculable, however.

Table I gives a comparison of tested and computed efficiencies, upward and downward components for three different types of fixture—a semi-direct, semi-indirect and direct-indirect type. These

TABLE I—Test vs. Computer Results for Three Luminaire Types.

Luminaire Type	Efficiency	Per Cent Up	Per Cent Down	Efficiency	Per Cent Up	Per Cent Down
A. Semi-direct Industrial	85.5	21.5	78.5	86.5	21.9	78.1
B. Semi-indirect Commercial	78.0	85.0	15.0	78.0	84.6	15.4
C. Direct-indirect Commercial	79.8	51.8	48.2	80.5	53.0	47.0

AUTHOR: Smoot-Holman Co., Inglewood, Calif.

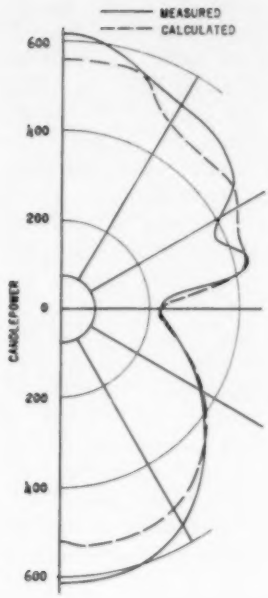


Figure 1. Calculated and measured transverse distribution curves for luminaire C.

are typical of the results obtained from practical units. Fig. 1 shows the measured and calculated transverse distribution of the direct-indirect fixture, showing the type of results obtainable with a relatively complicated fixture.

Prediction of performance of a complete design is only one area of applicability of this technique. More often, the technique is used to answer questions concerning proposed variations in existing designs, or to investigate only certain facets of a problem. For example, what will be the difference in performance of a fixture designed for T17 grooved lamps with the grooves oriented up and down or sidewise? Or, for the same shielding angle, what is the difference in efficiency between 13-inch and 16-inch reflectors used with T17 lamps? Answers to questions such as these point the way toward more sophisticated fixture design.

Techniques for programming the computer have been worked out, and are discussed in the main article. The art of discretization (dividing the fixture up for programming) is also discussed.

The major problem encountered in programming is the determination of the shape factors from surface to surface in the fixture. For most fixtures, the problem can be reduced to two dimensions, and aids such as the "protractor" in Fig. 2 can be used. This gives the shape factor of a surface with respect to a point on another surface. Determination of the shape factor for several points on the other surface and averaging gives shape factors for surface to surface with engineering accuracy.

(Abstract of IES Conference Paper No. 24.)

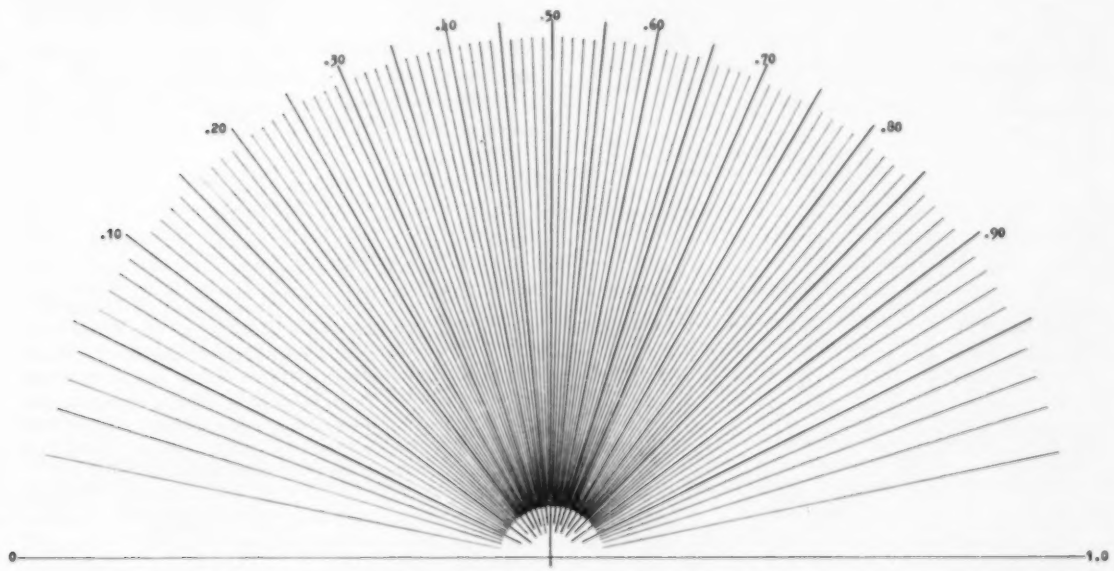


Figure 2. Centeno-Zagustin shape factor scale for two-dimensional differential-area-to-finite-area case.

S. K. Guth

A. A. Eastman

Comparison of
Visibility Measurement Systems

ALL VISIBILITY measurement systems are dependent upon the fact that human observers cannot judge accurately how much a visual task is above threshold visibility, but can only judge when the task is just barely visible or at the threshold of visibility. With both the Luckiesh-Moss (L-M) visibility meter and the Blackwell Visual Task Evaluator (VTE), tasks are reduced to threshold by viewing them through variable density wedges. Differences in recommended footcandles for a series of tasks measured with the two instruments may be attributed to the manner in which basic measurements are modified and interpreted, and to differences between the two instruments.

The principal differences in visibility as measured with the L-M meter and the VTE are: (1) the manner in which the task is reduced to threshold and (2) the type of relative visibility scale used. With the L-M meter the task is reduced to threshold by viewing it through a variable density photographic wedge which influences both the apparent brightness and contrast of the tasks. The scale of visibility is in terms of the visual size of a series of standard parallel-bar test objects.[1] To determine the illumination required for various tasks to be of equal visibility, a relative footcandle scale is applied to the visibility observations.[2]

With the VTE the task is reduced to threshold by viewing it through a partially silvered variable density wedge (Finch wedge) which reduces the apparent contrast of the task without reducing its average brightness. A unique feature is that the average brightness of the area viewed is kept constant by means of a light source incorporated in the instrument. The visibility of the task is rated in terms of the threshold contrast of a four-minute luminous disc viewed against a background of the same brightness as that of the task. Footcandles for equal visual performance of various tasks are obtained from experimentally determined curves.[3]

The apparent differences between the two methods of evaluation can be resolved by relating measurements of the same series of tasks obtained with the two instruments. This was done by first converting the L-M meter data of visual size to values of contrast for a three-minute parallel-bar test object which, for practical purposes, was found to be approximately equivalent to a four-minute disc. With this relationship determined, curves are used to convert the L-M meter observations to contrast values corresponding to VTE data. These values can be entered into any of the Blackwell performance curves to determine the required footcandle levels.

Fig. 1 illustrates the results obtained by evaluating several tasks with (A) the L-M meter, (B) the Blackwell performance data applied to L-M meter readings, and (C) the VTE. It can be seen that

AUTHORS: General Electric Co., Cleveland, Ohio.

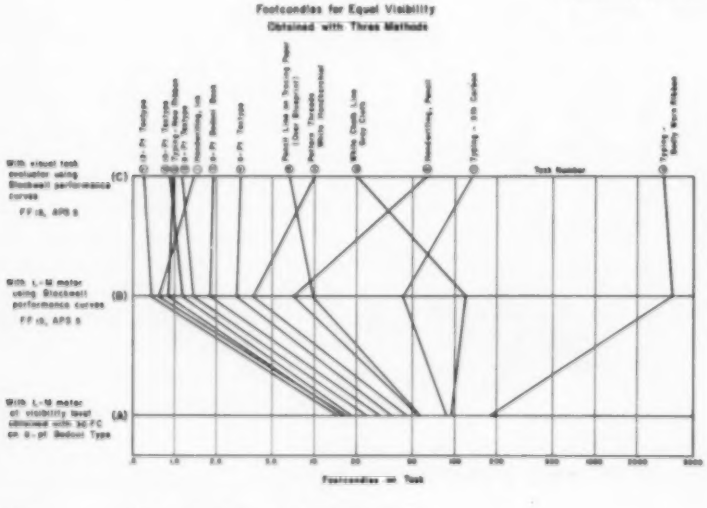

Footcandles for Equal Visibility
Obtained with Three Methods
With visual task evaluator using Blackwell performance curves
(C)
With L-M meter using Blackwell performance curves
(B)
With L-M meter at visibility level obtained with 30 FC on 6-pt Bodoni Type
(A)
Task Number
Footcandles on Task

Figure 1. Comparison of footcandles for equal visibility or equal performance, as determined with the Luckiesh-Moss visibility meter and the Visual Task Evaluator. The L-M meter was used with a monocular two-degree field in order to make viewing conditions similar to those with the VTE.

the footcandle levels obtained by applying the Blackwell visual performance data to the L-M meter readings agree very well in most cases with those determined directly by the VTE. The differences which occur can be explained by inherent characteristics and limitations of the two instruments.

Two important limitations of the VTE system are the relatively small (two-degree) monocular viewing field and the necessity for using the average brightness of the task when making measurements and when determining recommended footcandles from the data. Unusually high recommended footcandles for some tasks may result.

Evaluations made with the L-M meter may be affected by a bright light source in the field surrounding the task. The veiling brightness of the wedge may lower the visibility readings below what they should be. However, proper shielding of the instrument, as is recommended for its use, will usually guard against such effects.

While the two measurement systems each has its limitations, both are valuable for evaluating the visibility of visual tasks, the VTE as a precise laboratory instrument and the L-M meter as a practical portable instrument. Observations made with the L-M meter can be easily converted to values of contrast (corresponding to those obtained with the VTE) and use made of visual performance data for determining recommended footcandles.

1. Luckiesh, Matthew and Moss, F. K.: "Visibility—Its Measurement and Significance in Seeing," *Journal of the Franklin Institute*, Vol. 220, p. 43 (1935).
2. Luckiesh, Matthew, Guth, S. K. and Eastman, A. A.: "A New Scale of Relative Footcandles for the Luckiesh-Moss Visibility Meter," ILLUMINATING ENGINEERING, Vol. XVL, No. 4 (April 1950).
3. Blackwell, H. Richard: "Development and Use of a Quantitative Method for Specification of Interior Lighting Levels on the Basis of Performance Data," ILLUMINATING ENGINEERING, Vol. LIV, No. 6, p. 317 (June 1959).

(Abstract of I.E.S. Conference Paper No. 9.)

Philip F. O'Brien

Lighting Calculations for Thirty-five Thousand Rooms

THE IBM 709 digital computer was employed to prepare a comprehensive table of quantities which specify the illumination and luminous emittance distributions in 35,000 rooms characterized by different geometries and reflectance distributions. Included with this paper is an abstract of this table describing the lighting distributions in 160 rooms which represent a realistic range of reflectances and room geometries.

Calculations representative of a broad range of room characteristics suggest that rooms with extreme differences in proportion (*e.g.* a square room and an infinitely long hallway) but with equal domance* display transfer ratios which generally are not different by more than ten per cent.

TABLE I — Exact and Approximate Distributions of Light in an Infinitely Long Hallway.

$k_r = 1.0$; Room Height = 2.0; Room Width = 1.0. $\rho_3 = \rho_1 = 0.8$; $\rho_0 = 0.5$, Ceiling Lighting; S = Relative Distance from Ceiling.

S		Exact	Three-Surface Approximation	Per Cent Error	First Iteration	Per Cent Error
0.0	$L_1(S)/L_{0S}$	0.845	0.765	−9.5	0.809	−4.3
0.2	$L_1(S)/L_{0S}$	0.762	0.694	−8.9	0.738	−3.2
0.4	$L_1(S)/L_{0S}$	0.685	0.633	−7.6	0.669	−2.3
0.6	$L_1(S)/L_{0S}$	0.621	0.582	−6.3	0.607	−2.3
0.8	$L_1(S)/L_{0S}$	0.564	0.541	−4.1	0.551	−2.3
1.0	$L_1(S)/L_{0S}$	0.517	0.508	−1.7	0.510	−1.4
1.2	$L_1(S)/L_{0S}$	0.476	0.482	+1.3	0.470	−1.3
1.4	$L_1(S)/L_{0S}$	0.442	0.459	+3.9	0.438	−0.9
1.6	$L_1(S)/L_{0S}$	0.414	0.437	+5.8	0.414	+0.2
1.8	$L_1(S)/L_{0S}$	0.388	0.416	+7.2	0.391	+0.8
2.0	$L_1(S)/L_{0S}$	0.368	0.397	+7.9	0.368	+0.0
	L_2/L_{0S}	1.451	1.395	−3.9	1.455	+0.3
	L_3/L_{0S}	0.350	0.368	+5.2	0.352	+0.6

Luminous emittance ratios computed by a three-surface representation of symmetrical rooms may be employed to predict accurately the detailed illumination distributions within rooms. For example, the exact and approximate distributions in an infinitely long hallway are shown in Table I to agree within about ten per cent for a first approximation and, after one iterative computation, the errors are generally less than one per cent.

A method for the transformation of three-dimensional to two-dimensional problems is suggested to reduce the labor of computing detailed illumination and luminous emittance distributions.

(Abstract of IES Conference Paper No. 23.)

*Domance refers to room proportions and has also been designated the index of room proportion or room coefficient.

AUTHOR: College of Engineering, University of California, Los Angeles, Calif.

Applications

R. D. Bradley

The Use of
Polarized Light for General Illumination

THE PURPOSE of this paper is to explore the use of polarized light under actual working conditions, by means of a comparison between commercially-available, multi-layer, polarizing plastic and diffusing plastic.

To aid in the collection of data, two offices were constructed, decorated and furnished identically; both were lighted by recessed two- by four-foot units. The only difference between the offices was that one room was equipped with the polarizing material, the other with the diffusing plastic. Physical arrangements of the office used are shown in Fig. 1.

Two positions for the tasks were studied. The first had the mirror angle of the nearest unit (position "A"), and the second had no mirror angle visible to the task (position "B"). Three footcandle levels, 120, 90 and 40 were studied. The author attempted to simulate the tasks performed in an office and five tasks, believed to cover both extremes, were chosen for study.

Task #1—6th carbon copy made on an electric typewriter.

Task #2—Pencil writing on ruled paper.

Task #3—Text from a daily newspaper.

Task #4—Page from *National Geographic* magazine.

Task #5—Page from city telephone directory.

Observations were made with a Cottrell Contrast-Brightness Threshold Meter, modified with a 2-mm aperture for the right eye and clear configurated plastic between the left eye and the task. The plastic allowed the author to try both monocular and binocular vision when viewing the tasks. This instrument is of the visual extinction type and subject to the peculiarities of this type of instrument. In order to get readings that were within reasonable limits, it was necessary to take some 3000 observations.

The Cottrell Meter provides a factor of contrast

Figure 1. General view of office showing arrangements and lighting.

AUTHOR: Day-Brite Lighting, Inc., St. Louis, Mo.

sensitivity which is a measure of visibility. The results are tabulated as the per cent difference of these factors, comparing the room having the diffusers to the one having the polarizing material. The plus signs indicate improvement, the negative signs, a detrimental effect.

In most cases an improvement is noted. However, there are some conditions of task and lighting which produce negative results. Task #2 at position "A" with 120 footcandles has been consistently negative in all tests. Other negative values are a summation of some negative and some positive results. The conclusion, while not clearly defined, is that there are some benefits from polarizing light under the conditions of test. Different type of instrumentation would be quite helpful as the range of readings with present instrumentation points up the inability to duplicate specific readings.

TABLE I—Per Cent Difference in Contrast Sensitivity.

	Position "A"	Position "B"
120 Footcandles		
Task #1	+ 8	+20
Task #2	−10	+ 3
Task #3	− 7	+ 6
Task #4	+ 4	+12
Task #5	+12	+ 3
90 Footcandles		
Task #1	+ 2	+21
Task #2	+ 8	+20
Task #3	+13	+19
Task #4	+12	+ 3
Task #5	+ 9	+ 4
40 Footcandles		
Task #1	+15	+17
Task #2	+16	− 8
Task #3	+21	− 8
Task #4	0	+ 9
Task #5	+ 2	+11

(Abstract of I.E.S. Conference Paper No. 30.)

(Just prior to press time, this paper was withdrawn from the Conference program.)

Applications of the Quartz Lighting Lamp

Ronald L. Paugh

Carl J. Allen

THE QUARTZ lighting lamp has unusual physical and functional features which permit the design of reflectors and luminaires never before practicable with a general purpose light source. The characteristics of this new filament lamp which affect applications are: (1) high wattage in small volume bulbs, (2) high efficacy with practically no reduction in light output throughout life, (3) efficient operation on high-volt as well as on standard 120-volt circuits, (4) increased life without the usual accompanying sacrifice in filament temperature and efficacy.

The 500-watt 120-volt lamp is in a T3 bulb about five inches long. Its mean efficacy through its 2000-hour life is 21 lumens per watt. The 1500-watt 277-volt lamp is also in a T3 bulb and is about 10 inches long. Its life is also 2000 hours and its mean efficacy is 22 lumens per watt.

The lamp's small bulb diameter makes possible the use of small size reflectors possessing a high degree of optical control. For example, the 500-watt developmental parabolic trough reflector shown in Fig. 1 can produce a fan-shaped beam of light only six degrees across its narrowest dimension. In the plane of the lamp the beam has a broad distribution. Lighting for building fronts, sports fields, airport runways and show windows are a few examples where such a beam shape has advantages.

The quartz lighting lamp has a few limitations which must be considered in designing and applying equipment. The lamp must be operated within about four degrees of horizontal in order that the iodine will not separate out to the low end of the lamp. The molybdenum lead-in wire must be kept below 350C. Above this temperature the molybdenum wire oxidizes rapidly. The bulb wall temperature must be kept above 250C, otherwise the iodine cycle will not operate. The present lamps

AUTHORS: General Electric Co., Cleveland, Ohio.

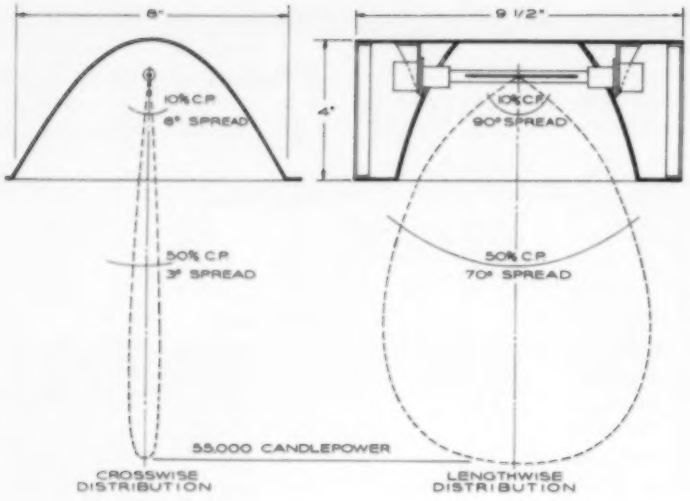


Figure 1. Developmental parabolic trough reflector with parabolic end plates.

must be individually fused to protect against the lamp rupturing due to arcing at the end of life. This is not a new condition as it is common practice to fuse, internally, all gas filled lamps of the higher wattages. Care should be taken that combustible materials do not come in contact with the lamp, as the 500-600C bulb wall temperature is above the kindling point of many common items.

The first application of a quartz lighting lamp was in connection with wing tip lighting on jet airplanes. However, three unusual lighting installations are currently under test using quartz lighting lamps. These involve airport runway floodlighting, shown in Fig. 2, airport runway-taxiway marker lights and an oxygen regenerative cell for submarine and space travel use.

It is difficult to predict at this time whether the quartz lighting lamp will be more widely used in special applications or in the general lighting of large area industrial installations. A possible industrial application for the 1500-watt 277-volt quartz lighting lamp is on traveling cranes where the available voltages are commonly in the higher voltage ranges. Exploratory cost analysis indicates an initial cost for a 1500-watt quartz lighting lamp industrial lighting installation susbtantially lower than any other common system. This is primarily due to the lamp's high mean efficacy, its ability to operate efficiently on 277 volts and an assumption that a luminaire for its use would be relatively high in utilization and moderately low in cost.

The quartz lighting lamp gives the engineer, designer, and user a new, unique and useful light source. Because of its small size and high maintained output it promises to provide better solutions to many of the lighting problems of today and tomorrow.

(Abstract of I.E.S. Conference Paper No. 33.)

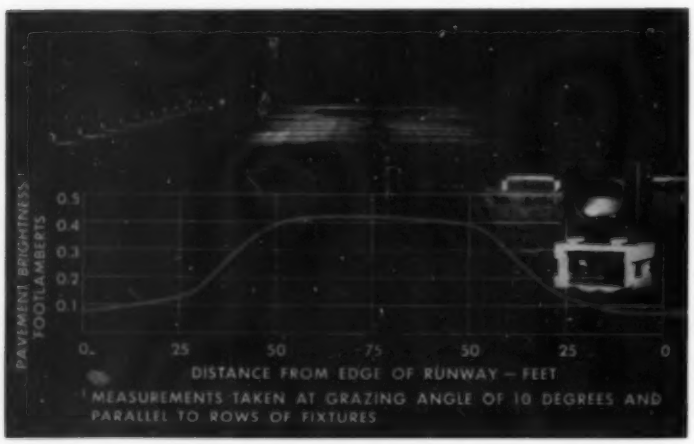


Figure 2. Developmental runway lighting system using a 200-watt T-4 6.6-ampere quartz lighting lamp in a fixture as shown in insert.

Proposed Method of Measuring the Hiding Power of Light Shielding Materials

Warren O. Benjamin

Clarence W. Clarkson

ALTHOUGH the terms *Hiding Power* and *Obscuring Power* have been used for many years, especially with the advent of the fluorescent lamp, there is no generally accepted definition of them. It is proposed that the term *Obscuring Power* be used and be defined as: "The effectiveness of a shielding material in obscuring the outline of a light source." The relation between the maximum and minimum brightnesses of a shielding medium does not necessarily show this. The effectiveness of a device in obscuring the light source is actually dependent on the maximum gradient of brightness across the device, or the fastest rate at which the brightness changes across any device.

In research studies anticipated on the subject of reflected glare, uniformity of brightness of a shielding material in a luminaire should be considered as one variable. To make this characteristic a useful tool, it is proposed that the Obscuring Power Factor (OPF) expressing the effectiveness of a material in obscuring the light source be defined as: "The ratio of the maximum gradient of brightness of a material shielding the same light source." Although all data taken were based on a fluorescent lamp as a source, the relation would be the same with any other type of source. Various other characteristics used today to compare light shielding materials have been defined and discussed in the paper to point out that obscuring power cannot tell the whole story of the effectiveness of a material as a lighting product.

To magnify the gradient of brightness of a material, a fluorescent lamp with a matte black background was used as the test source. Twenty-three materials were tested with the brightness meter normal to the sample. Eight representative samples were chosen from these and additional tests made with the same light source, but with the brightness meter 30 degrees from normal to the surface and with light centers 1¾ and 2¾ inches behind the material. The whole series was then repeated with a white enamel background. Results at 0 and 30 degrees incidence show the test materials in the

AUTHORS: Corning Glass Works, Corning, N. Y.

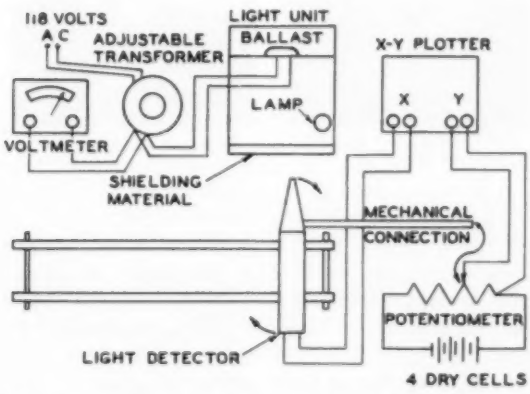


Figure 1. Schematic diagram of laboratory apparatus for measuring brightness gradients.

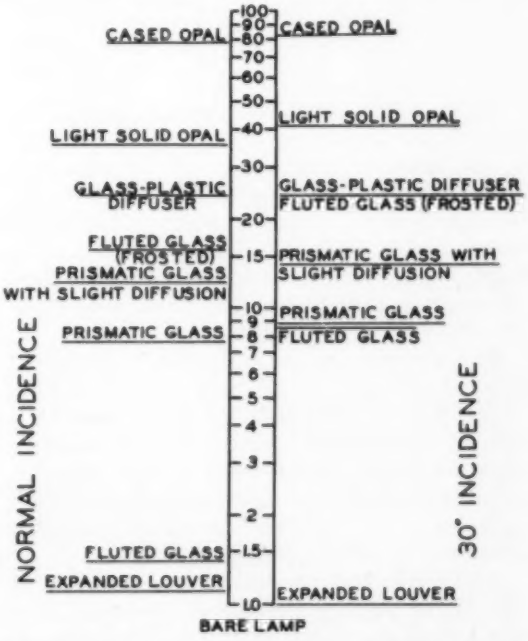


Figure 2. OPF scale showing relation of eight light-shielding materials at 0 and 30 degrees incidence.

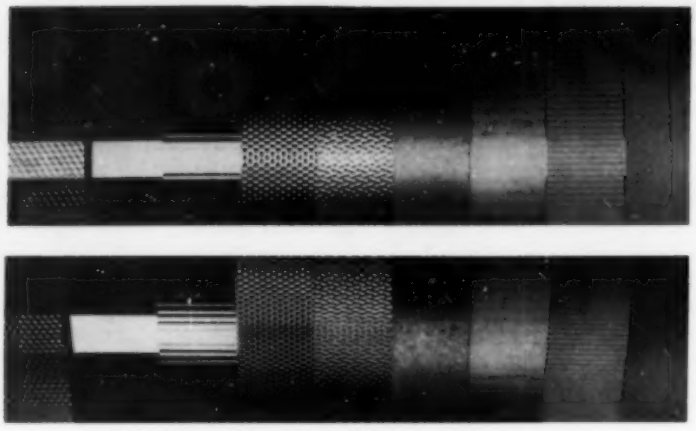


Figure 3. Photo of fluorescent lamp with flat black background, demonstrating appearance of OPF's from Fig. 2, with 0 degree incidence. Left to right: expanded louver material, bare lamp, fluted glass, prismatic glass, prismatic glass with slight diffusion, glass-plastic diffuser, fluted glass (frosted), light solid opal, cased opal.

Figure 4. Same as Fig. 3, but with 30 degrees incidence.

same general order of OPF, with some variation in the span between individual samples. It is expected that some particular angle of incidence in the reflected glare zone (0-45 degrees) may be of more significance than others in the study of reflected glare. Until that angle might be established, it is proposed that normal incidence be standard, with a matte black test luminaire background, and with the light center at 2¾ inches behind the shielding material.

Test data were accumulated with the equipment shown in Fig. 1. The X-Y plotter plots the location of the brightness meter with respect to the light source location on one scale, and the brightness in candles per square inch on the other scale, simultaneously. Fig. 2 shows the relation of the eight test materials according to their OPF, at 0 and 30 degrees incidence. Figs. 3 and 4 show photographically the data in Fig. 2.

(Abstract of I.E.S. Conference Paper No. 31.)

Integrated Lighting-Air Conditioning Systems

J. E. Flynn

W. S. Fisher

CURRENT lighting recommendations for commercial and industrial buildings have reached a point where the lighting load may have considerable influence on thermal design considerations. Continuing trends toward higher levels of illumination, as well as increased use of wall and accent lighting, have introduced additional human comfort and economic factors, due to the heat introduced by the lighting system.

Many current examples of lighting in commercial and industrial areas testify that 100, 200, and 400 footcandles are often desirable and economical to provide, notwithstanding the cost of supplying these levels with the necessary cooling. However, techniques which combine certain aspects of air conditioning and lighting indicate the possibility of substantial reductions in over-all costs.

All electric light sources generate heat in addition to the primary purpose of producing light. Fig. 1 shows the dissipation of watts from a fluorescent lamp and a fluorescent lamp-luminaire combination, all of the wattage eventually becoming heat energy. Heat build-up in the luminaire may become substantial with the convection-conduction heat and ballast load initially trapped in the unit and part of the radiant energy absorbed by the luminaire surfaces. Much of this heat can be removed from the luminaire by cooling. If the

AUTHORS: General Electric Co., Cleveland, Ohio.

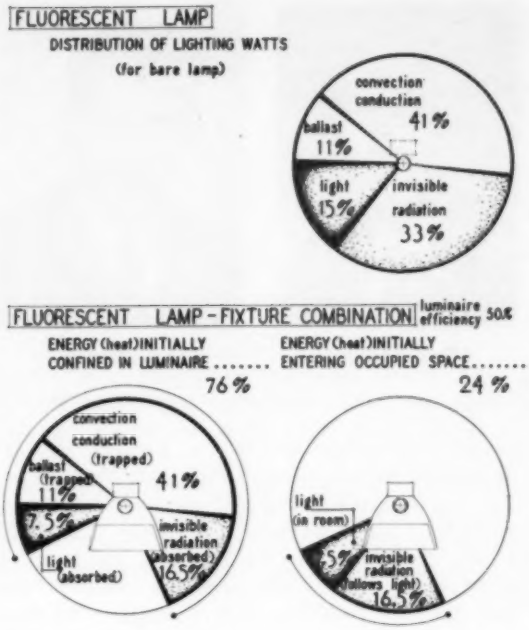


Figure 1. Energy output for a 40-watt fluorescent lamp plus five watts ballast loss.

luminaire heat is removed to the outside before it enters the occupied space, substantial reductions in air conditioning tonnage and air handling can be realized. In addition, room comfort will be better since less heat enters the space. Lamp and ballast operating conditions will also be improved.

Fig. 2 indicates proposals for control of lighting heat. Some of the room air is exhausted through the luminaires which carry the heat away before it affects room comfort. For room cooling, this air may be moved directly to the outside and replaced by new, cooler air, or when the exhaust temperature is lower than the outdoor air, it may be recirculated through the cooling system.

Air circulation in cold weather may be through the system in a similar manner, where it picks up heat and then is returned to the occupied part of the room to reinforce (or even replace) the heating system.

A full-scale integrated lighting-air conditioning installation at Nela Park has been tested and appraised. The system employs 1500 ma lamps of non-circular cross-section in ventilated luminaires. When four cfm of air per each 100 luminaire watts is exhausted through the lighting units about 40 per cent of the total lighting heat is removed. This air may be that which is normally exhausted to the outside and replaced by fresh air in typical air conditioning practice. In office buildings the air available for exhaust is often more than enough to remove 40 per cent of the heat from a 100-foot-candle installation employing luminaires similar to those tested.

Ventilation and cooling systems integral with the lighting design offer a number of potential advantages:

(1) A substantial heat reduction in rooms, improving occupant comfort and reducing air conditioning tonnage and quantity of air needed for cooling.

(2) Application of lighting as a heating system.

(3) Provision for luminaire ambients more favorable for efficient operation of fluorescent lamps and ballasts.

(Abstract of I.E.S. Conference Paper No. 4.)

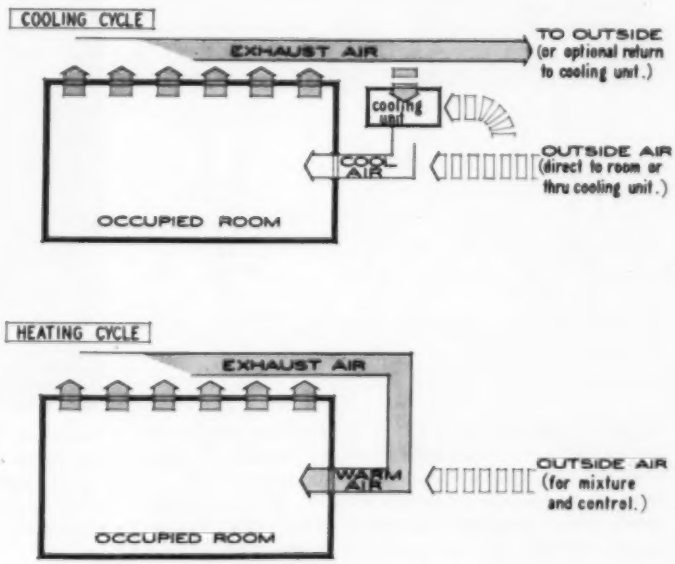


Figure 2. Schematic diagram of a method for controlling luminaire heat. Air is usually exhausted to outside on cooling cycle, recirculated on heating cycle. Other variations are indicated.

Designing Low Brightness Luminaires For Higher Lighting Levels

D. R. Phillips

Q. D. Dobras

THE TREND toward higher lighting levels has steadily increased through the years. The new IES recommended levels of illumination include general lighting levels up to 300 footcandles, and levels of 500 footcandles or more are already in actual use. As lighting levels continue to increase, the problem of luminaire brightness control becomes more acute. Therefore, it is appropriate to develop new and improved methods of controlling luminaire brightness so that lighting users can obtain the benefits of these higher levels with good visual comfort.

It is the purpose of this paper to analyze one method of brightness control that has proved to be a satisfactory answer for higher lighting levels and for use with higher brightness light sources. This method makes use of a specular wedge louver with parabolic curved sides.

This parabolic shaped louver has two unique advantages: (1) it permits complete brightness control in the shielded zone regardless of the size or brightness of the light source; and (2) it provides brightness control equivalent to black or dark gray louvers but at a much higher efficiency.

These advantages are obtained by utilizing the design technique illustrated in Fig. 1. In this illustration adjacent louver blades are shown. Line *AD* is a parabolic curve with the focus located at point *B* and the axis parallel to line *AC*. Line *BC* is also a parabolic curve but with the focus at point *A* and with the axis parallel to line *BD*. The axes for both parabolas form an angle with horizontal line *CD* equal to the shielding angle, which in this example is 45 degrees.

It can be seen that all light from the light source reflected by the parabolic louver sides is emitted at an angle equal to or greater than the shielding

AUTHORS: General Electric Co., Cleveland, Ohio.

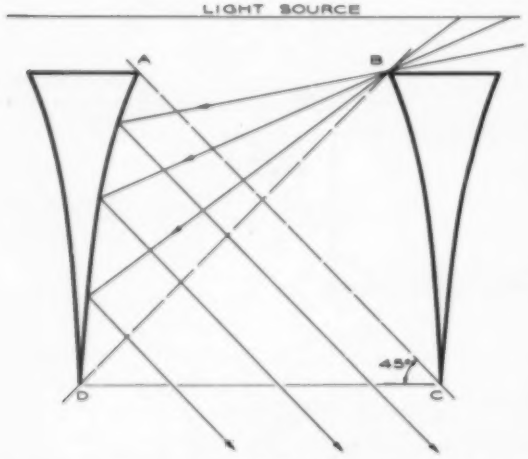


Figure 1. The pattern of light reflectances shown for several light rays originating above the louver. All light from the light source that strikes the louvers is reflected at an angle equal to or greater than the shielding angle. Thus, louver brightness in the shielded zone is independent of the size or brightness of the light source.

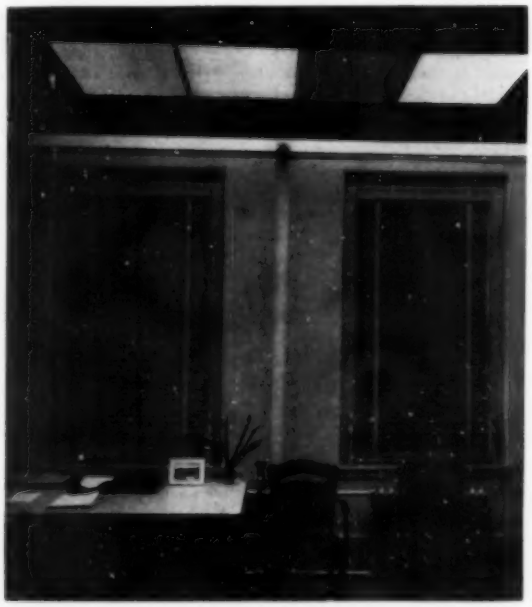


Figure 2. In this office the low brightness of the specular wedge grid is a striking contrast to that of the four louver grids which it surrounds. From left to right: white enamelled steel, semi-diffuse aluminum, gray enamelled steel and white translucent plastic. All louvers have 45- by 45-degree shielding.

TABLE I—Design Data—Large Area Luminaires.

Luminaire Type*	Efficiency (Per Cent of Bare Lamp)	Coefficient of Utilization Room Ratio — 2.0 (E) 70, 50, 10	50, 30, 10	Average** Luminaire Brightness (fL) Angle from Nadir 50°	60°	70°	80°
1. Diffuse Plastic Grid, ½" Cell	52	45	41	700	600	540	500
2. 85% White Enamel Grid, ½" Cell	43	36	33	590	450	350	290
3. 40% Gray Enamel Grid, ½" Cell	25	22	21	370	250	230	220
4. Semi-Diffuse Aluminum Grid, ¼" Cell	58	49	45	790	600	480	410
5. Specular Wedge Grid, 2" Cell	43	40	38	80	60	60	60

*Tested in a two- by four-foot panel with cavity efficiency of 85 per cent; 45- by 45-degree shielding for each type.
**Based on 500 footcandles average maintained in service.

angle. Thus, louver brightness in the shielded zone is not dependent upon light source brightness. However, it does depend upon room surface brightnesses.

To obtain quantitative values of brightness and of lighting efficiency, actual louvers utilizing the parabolic wedge principle were designed and built. These louvering devices were given complete photometric tests and compared to various other types of brightness control media.

The data obtained indicate that, of the systems tested, the only ones that combine good lighting efficiency and low luminaire brightness are those utilizing the parabolic wedge louver design.

(Abstract of I.E.S. Conference Paper No. 2.)

Performance Characteristics of Combination Air Diffusing Troffers

M. L. Quin

W. W. Kennedy

A RAPIDLY advancing architectural trend toward greater freedom in space planning has introduced the self-sufficient planning module, any multiple of which may be combined to provide a complete luminous, thermal and acoustical environment within a resulting space expansion. This move, together with a growing multi-use of prefabricated materials, as dictated by flexibility requirements, has resulted in the integration of lighting and air handling functions within a single flush-mounted element in the center of each module. Interest in combination diffusers has been further stimulated by the resulting esthetic refinement in the appearance of ceilings and components.

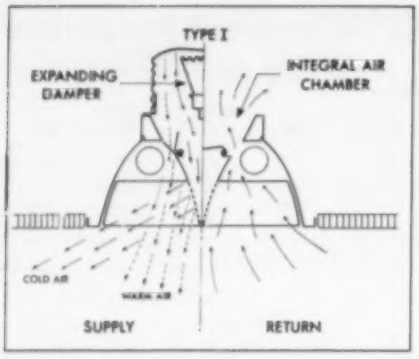
Light and air diffusing performance characteristics of combination units hold many aspects which are of mutual interest to both professions. Two diffuser types have been selected to illustrate integral air chamber (Fig. 1) and separate air chamber (Fig. 2) designs, each of which may function interchangeably as a supply outlet for conditioned air or return outlet to exhaust room air. Investigations include the following:

Diffuser Selection Data for each type are established through comprehensive tests which include temperature and velocity traverses in spaces simulating actual conditions. Operating capacities are related to design conditions to assure diffuser performance within limits of comfort standards for air distribution equipment.

Pressure Drop and *Noise Level Data* show the resistance of the diffuser to air flow and NC ratings developed from octave band analyses.

Relative Light Output as a variable of air temperature and velocity is compared for integral and

AUTHORS: Day-Brite Lighting, Inc., St. Louis, Mo. and Barber-Colman Co., Rockford, Ill., respectively.



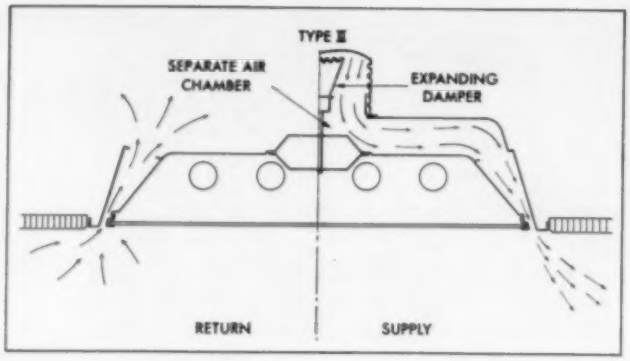


Figure 1 (left). Half sections of a louvered diffuser showing air flow through an integral air chamber. Figure 2 (right). Half sections of an enclosed diffuser showing air flow through a separate air chamber.

separate air chamber diffusers throughout various operating ranges.

Ballast Temperature Characteristics are analyzed during cooling and heating cycles of operation, including upper limit safeguards, to assure that allowable operating temperatures are not exceeded in the event of malfunction of the warm air distribution system.

(Abstract of I.E.S. Conference Paper No. 1.)

Application Possibilities of

Wide Range Dimming of Fluorescent Lamps

Philip E. Massie

Allen B. Rosenstein

Dimming of the 40-watt T-12 fluorescent lamp has been practiced on a commercial basis for about ten years with varying degrees of success. The common types of commercial dimmers had a dimming ratio of 100 to 1 with flicker often present in the lower ranges. Developments of the past two years have changed this picture. The requirement for dimming of lamps other than the F40T12 arose in the aircraft industry. Dimming ranges greater than 100 to 1 were found necessary. Development programs have fulfilled these requirements.

The present generation of turbine-powered aircraft with their primary power system of 115/200 volts, 400 cycles present the first practical opportunity to use fluorescent lamps in aircraft. Limited numbers of fluorescent lamps have been used in aircraft of past years but the direct current primary power system required the use of rotary inverters to develop the a-c required for practical operation of fluorescent lamps. The weight and efficiency penalties of the inverters made the broad use of fluorescent lamps impractical. With the advent of the primary a-c systems, it is possible for aircraft to utilize the advantages of fluorescent lighting. Some form of light variation was found necessary. The first consideration was in the cockpit where the high altitude lighting environment required high light levels. Operation at other altitudes required that the pilot be able to vary the light level. Passenger cabins are lighted by dimming systems to assist in the crowd handling problem of aircraft operation. Single- and two-level fluorescent lighting

Authors: Day-Ray Products, Inc., South Pasadena, Calif. and University of California, Los Angeles, Calif., respectively.

are used on the aircraft for specific lighting tasks. With space in aircraft at a critical premium, the T-5 fluorescent lamp was selected. To meet the high vibration environment and to permit dimming, rapid-start T-5 lamps were developed by two lamp manufacturers. This permitted elimination of the starter, always a maintenance problem in aircraft.

The requirements for variation of light level had not been determined prior to the aircraft application. A measure of dimming range can be determined by comparing two recommended lighting levels. Consider the theatre during the picture with a level of 0.1 footcandle and a terminal ticket counter with a level of 100 footcandles. This constitutes a range of 1000 to 1. Situations similar to each of these will exist in the aircraft. Early "guestimates" of dimming range were far short of required ranges. The non-linear response of the eye was not considered. The eye responds to orders of magnitude in light variation. This makes the eye response roughly logarithmic. Thus, a dimming system must be considered on the basis of orders of magnitude. Present aircraft dimming systems are working in the fourth order with experimental units well into the fifth order of magnitude.

Fluorescent dimming systems can be divided into two classes: voltage control and current control. Both types of control are in use in commercial systems, the thyratron system showing a method of current control. In the aircraft lighting system, the use of the T-5 lamp presents severe problems in flicker elimination. It has been shown that flicker is a function of lamp incremental impedance and the T-5 lamp has the highest incremental impedance of any lamp tested. Although both voltage and current control dimming systems are in use in aircraft, the series saturable reactor current control system provides several advantages. This system can match the high impedance of the T-5 lamp with the use of excessive voltage levels. It provides the ability to operate large systems from small controls, due to the power gain of the ballast. The weight of this system is competitive with incandescent installations. Power and maintenance costs are much reduced.

This type of ballast has been designed for operation of lamps up to 800 mils and on 60 and 400 cycles. Investigations are in progress on 1600-cycle systems for use in manned orbital vehicles.

Dimmable fluorescent lamp circuits are applicable in most locations where incandescent circuits are now used. Theatre, auditorium and church lighting are examples. There are other possibilities for dimming circuits: restaurants, stores, factory and office work areas and homes. This technique provides the ability to reduce the light level without seriously altering the distribution. This can be used in the home where an area must serve more than one function — a living room which may be work area at one time and used for relaxed activities at other times.

With the wide range dimming of fluorescent lamps now practical, the advantages of fluorescent lamps can be extended to most dimming situations. The power gain of the new ballasts will permit the control of large lighting systems from single controls.

(Abstract of I.E.S. Conference Paper No. 34.)

A Constant Wattage Ballast For Two or More Mercury Lamps

V. W. Olson

WE ALL KNOW the significance of light. New and improved lighting methods are as important to super-highways, shopping centers and service stations as are longer and wider runways for the new jets. A constant wattage ballast that will operate two, three, four or any other number of lamps, each lamp operating independently, will undoubtedly play an important role in the lighting industry.

One simple way to get independent operation of all lamps is to use an individual ballast for each lamp. However, a two-lamp ballast, usually can be made smaller and more economically than two single-lamp ballasts. Besides the initial savings in size, weight and production costs, the contractor is also saved installation costs. He has only one input or primary circuit to install and uses less space.

AUTHOR: Jefferson Electric Co., Bellwood, Ill.

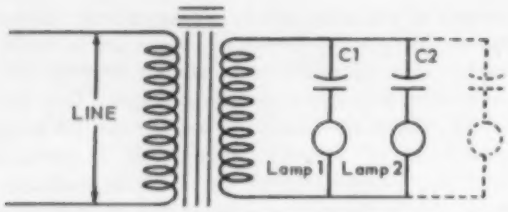


Figure 1. Circuit diagram for two-lamp constant-wattage ballast, isolated, high-reactance type.

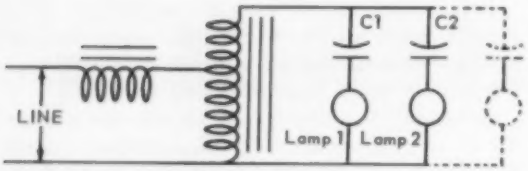


Figure 2. Circuit diagram for two-lamp constant-wattage ballast, non-isolated, reactor type.

Comparisons of conventional ballasts to constant wattage ballasts show that in a conventional ballast there is a total variation in watts to the lamp between maximum and minimum of from 13 per cent to 22 per cent, depending on the type of conventional ballast used. (See Fig. 4.) Now in a constant wattage ballast, for a line voltage variation of plus or minus 13 per cent or a total variation of 26 per cent, the wattage to the lamp is normally held to plus or minus two per cent or a total variation of four per cent. For this total of four per cent change in wattage, the contractor has no taps to select. (See Fig. 5.) In most applications there is no worry about the voltage drop from one end of a long run to another. All lamps will burn with the same brilliance within the tolerance of lamp or ballast manufacturing.

The principle of constant wattage has been applied to two-lamp circuitry. Most two-lamp constant wattage ballasts, as manufactured today, use a circuit which places the two lamps in series with

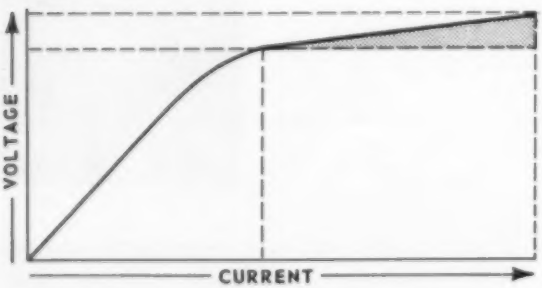


Figure 3. Typical current-voltage diagram showing operating range of secondary current (lamp current) and secondary voltage for constant-wattage circuits.

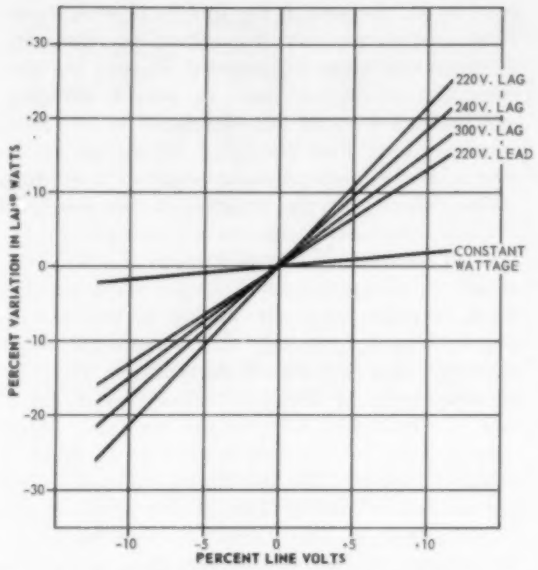


Figure 4. Graphical representation of lamp wattage regulation with variation in line voltage for typical mercury lamp ballasts.

each other. This means that if one lamp fails or is extinguished for any reason the other lamp will go out also. The purpose of this paper is to discuss a constant wattage ballast which does not have this unfavorable feature. A ballast construction using the circuit in either Fig. 1 or Fig. 2 can give constant wattage operation to two or more lamps with the added feature that if any lamp goes out the others remain lit.

(Abstract of I.E.S. Conference Paper No. 5.)

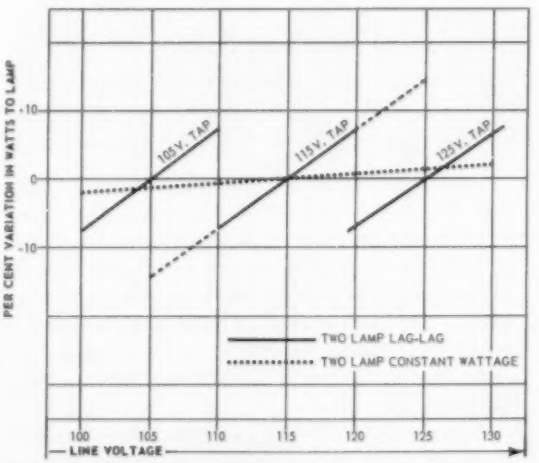


Figure 5. Typical regulation curve of a two-lamp lag-lag ballast with primary taps, compared to a two-lamp constant-wattage ballast without taps.

Roadway Lighting

A Versatile Lighting System For Highway Tunnels

Harold Skootsky

John R. Brass

THIS PAPER describes the development of a continuous line, fluorescent tunnel lighting system which it is believed will satisfy, with little compromise, the requirements of proper tunnel lighting as determined by studies outlined previously.[1] These requirements include daytime lower wall brightness of 30 to 60 footlamberts in the 300-foot long "entrance zone," 5 to 10 fL in the "central zone" and nighttime lower wall brightness of one-half to one footlambert. It should be noted that the brightness values given above indicate that a day to night dimming ratio of up to 60:1 may be required, preferably without interruption of the continuous line of light.

AUTHORS: State of California, Division of Highways, San Francisco, Calif.

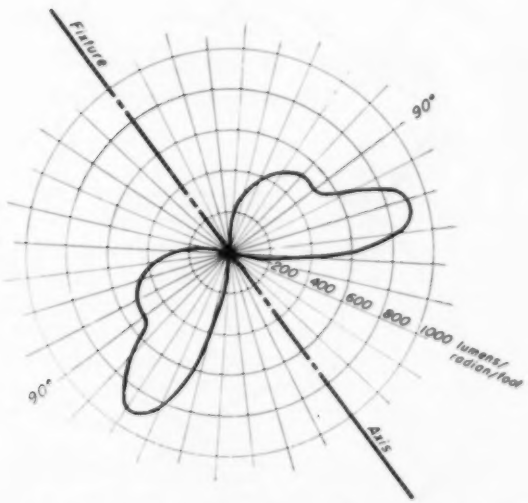


Figure 1. Curve showing cylindrical luminous intensity (I_c) in lumens/radian-foot at center of ten or more three-lamp units.

Other design objectives are as follows:

(1) Special light control characteristics to provide relatively uniform wall and ceiling brightness.

(2) Lamps shielded from drivers' view.

(3) Dust and spray-tight luminaire construction without sacrificing ease of relamping.

(4) One piece plastic cover to be easily removable for thorough cleaning and not requiring a metal frame or other hardware attachment.

(5) Branch circuit or feeder wireway within luminaire shell to eliminate expense of separate wireway (or conduit with outlet boxes) and to facilitate installation in existing tunnels.

(6) High-voltage branch circuits to eliminate auto-transformers in ballasts and reduce line losses.

(7) Easily accessible, high quality, unity power factor ballasts.

(8) Heat "sink" ballast mounting.

(9) Free air circulation behind luminaire shell to cool ballast and reduce air temperature in the luminaire.

(10) Highest quality, corrosion-resistant construction to reduce maintenance expenses to a minimum.

Fig. 1 shows the light distribution of a long line

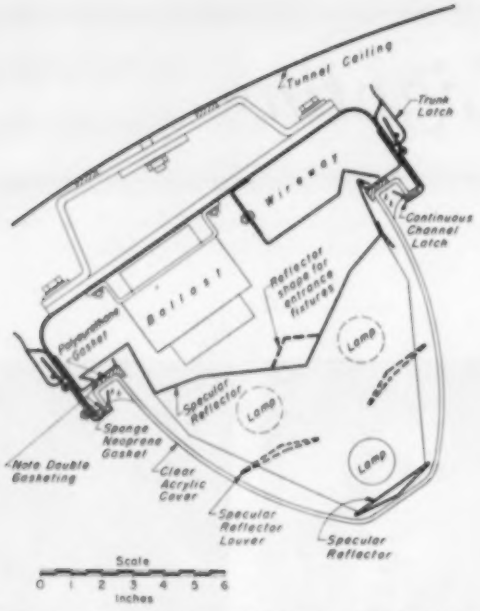


Figure 2a. Cross-section of luminaire. Dashed lamps and reflectors are part of entrance luminaires only. Lamps are 96T12 cool white extra high-output, operated at 1400 ma in entrance zone during daytime; 600 ma in central zone, daytime; lower lamp only at 60 ma throughout, at night.

of entrance luminaires during the day. The shape of the curve is essentially the same for night operation and for single-lamp luminaires during the day, although the light intensity values will, naturally, be lower.

The cross-section and mechanical operating features of the luminaires are shown in Figs. 2a, 2b and 2c. As may be noted in Fig. 2c, the lamp assembly can be swung down quickly into the plastic cover for access to the ballast and wireway. For further ease of maintenance, the cover may quickly be removed for cleaning. Neither of these operations requires the use of tools. The luminaire is also adaptable to center mounting in tunnels with high ceilings and will provide even better uniformity of wall brightness in these cases, than when mounted as shown in Fig. 3.

It is very difficult to imagine the quantity of dirt which can accumulate in a tunnel in a short time. Conditions are far more difficult than for ordinary street lighting luminaires. Conventional methods of sealing tunnel lighting luminaires are not suitable; that is, any method which relies entirely on squeezing a long gasket between a cover frame and a housing flange ordinarily develops small gaps in the seal through which dust and water may enter. To prevent the entry of water into the luminaire

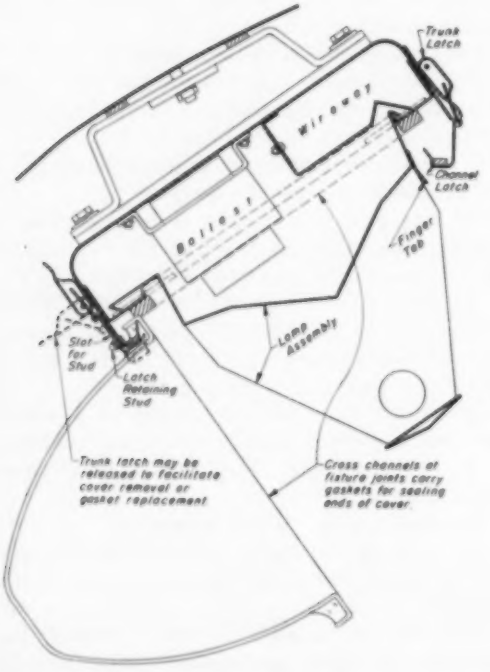

Trunk Latch
Wireway
Channel Latch
Ballast
Finger Tab
Lamp Assembly
Slot for Stud
Latch Retaining Stud
Trunk latch may be released to facilitate cover removal or gasket replacement
Cross channels at fixture joints carry gaskets for sealing ends of cover

Figure 2b. Illustration of hinging of cover and operation of latches.

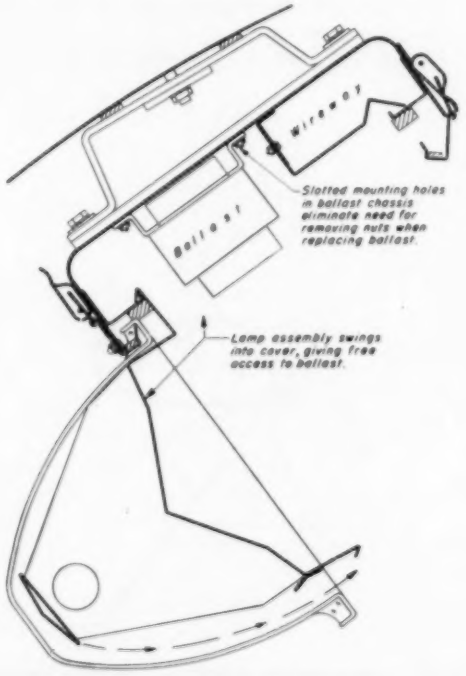

Wireway
Slotted mounting holes in ballast chassis eliminate need for removing nuts when replacing ballast.
Ballast
Lamp assembly swings into cover, giving free access to ballast.

Figure 2c. Lamp assembly swung into open cover for access to ballasts.

when the tunnel is being cleaned by a high pressure spray, a double-gasketed and baffled method of sealing a long luminaire is preferred (see Fig. 2). In this design, the spray of water is deflected from the main gasket by the continuous channel latch and cannot enter the luminaire. Any water which by-passes the channel latch loses its force and drains out the end of the latch. This latch is operated by three trunk latch type operators which automatically apply the correct sealing force to the gaskets.

Special 480-volt, 60-cycle ballasts are required to obtain many of the advantages ordinarily claimed for high frequency ballasts (such as low losses and the elimination of auto-transformers), and particularly to obtain the dimming feature mentioned earlier. A relay has been incorporated into each ballast to switch lamps to the night inductor without interrupting cathode filament current. In entrance zone luminaires, this relay also switches off the upper lamps during night operation, although the cathode filaments continue to operate. The inductors have been designed for low losses, minimum distortion of lamp current wave shape and long service life. The heater transformer provides the proper cathode filament voltage at all times.

It is believed that this newly-developed tunnel lighting system will provide, economically, a degree of driver visibility, particularly during the daylight hours, which has not previously been achieved, and at the same time, avoid the pitfall of excessive night lighting and power consumption.

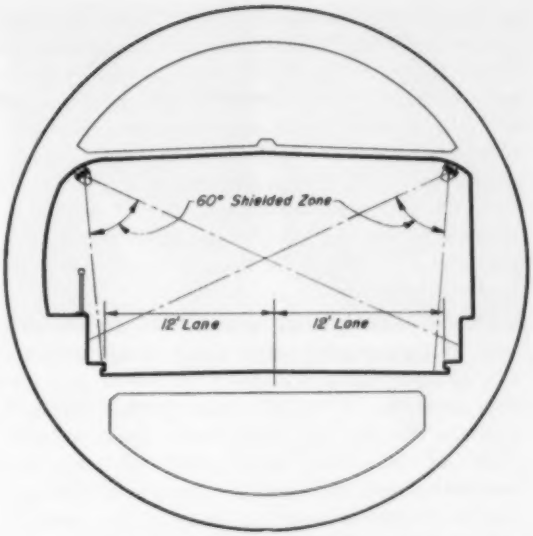


Figure 3. Typical cross-section of tube showing luminaire orientation, shielding and light control.

1. Trosper, G. A., Skootsky, H. and Brass, J. R.: "A New Approach to Highway Tunnel Lighting." ILLUMINATING ENGINEERING, Vol. LII, No. 3, pp. 137-149 (March 1957).

(Abstract of I.E.S. Conference Paper No. 26.)

Evaluation of Methods for

Localized Cooling of Fluorescent Lamps In Outdoor Luminaires

M. E. Keck

WHILE IT IS a well known fact that fluorescent lamps vary in light output as a function of ambient temperature, many engineers are "in the dark" to to why, how much, and what can be done about it. While this paper does not have final and complete answers to all of the above questions, it does "cast some light" on the subject.

The paper discusses the causes of light output variation as a function of ambient temperature, indicates the meaning of the curves of such variation published by lamp manufacturers for bare lamp operation, and indicates the radical departure from those curves when lamps are enclosed in outdoor street lighting or floodlighting luminaires (Fig. 1). Since change in light output as a function of ambient temperature is most pronounced for highly loaded lamps (1500 ma) the paper deals chiefly with those lamps.

Data in this paper establish conclusively that by

AUTHOR: Westinghouse Electric Corp., Cleveland, Ohio.

cooling all or part of the fluorescent lamp, the light output *vs* ambient temperature for lamps enclosed in a luminaire can be altered quite drastically. Four basic methods of cooling the lamps are examined and data presented as to advantages and disadvantages of each. These methods include: (1) general circulation of air within the luminaire; (2) localized stream of cool air on one part of the lamp; (3) conduction cooling of a localized spot on the lamp; and (4) cooling by thermo-electric refrigeration of a localized spot on the lamp.

From the data in this paper, it is believed that both design and application engineers will be better able to understand the theory, problems and possible solutions. From this base further advancement in the art will undoubtedly lead to better choice of equipment, better design of lamps and luminaires, and more positive control of the light output of luminaires, regardless of the ambient temperature conditions under which they are operated.

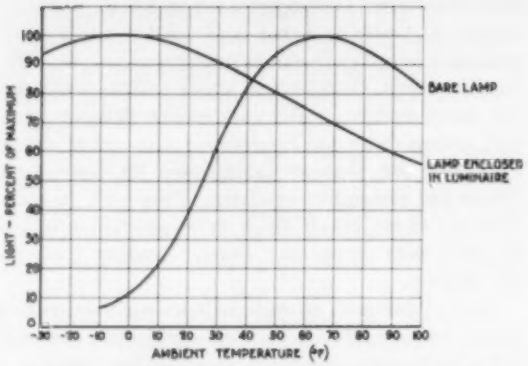


Figure 1. Variation in light output with ambient temperature for 1500-ma T12 fluorescent lamps when operated in free air and when operated in a luminaire of the type where no lamp cooling is utilized.

(Abstract of I.E.S. Conference Paper No. 27.)

Adaptation on Runway and Turnpike

S. C. Peek

D. E. Spencer

THE ENGINEERING of outdoor lighting has generally neglected the state of adaptation of the eye. However, since outdoor fields of view are highly non-uniform, improvement in vision may have little to do with quantity of light. Greater and more economical improvement in vision can often be obtained by controlling the light from a small number of lamps rather than by employing many powerful lamps with little or no control of the light distribution.

The effect of non-uniformity in the field of view is studied by specifying the state of adaptation of the eye. The visual significance of varying quantity and quality of light is analyzed by the use of the delos method developed by Moon and Spencer,[1] and the method is extended to vision in fog and to the transient case. Because the problem is essentially a steady-state one, the simplest of the applications is to low-mounted fluorescent lighting of a turnpike. The periodic adaptation problem is confronted in the study of high-mounted street lighting. Runway lighting problems are more difficult because they involve a transient state of adaptation. The effect of approach lights and of surface-mounted lights on vision at touchdown is also considered. The most important result of the analysis of outdoor lighting by the delos method is that definite guidance on future improvements in design is made possible.

AUTHORS: Sylvania Lighting Products, Salem, Mass., and University of Connecticut, Storrs, Conn., respectively.

1. Moon, P. and Spencer, D. E.: "Visual Data Applied to Lighting Design," *Journal of the Optical Society of America*, 34, p. 605, 1944; "The Visual Effect of Non-Uniform Surrounds," *Journal of the Optical Society of America*, 35, p. 233, 1945; *Lighting Design*, Chapter VIII, Addison-Wesley Press, Cambridge, Mass., 1948.

(Abstract of I.E.S. Conference Paper No. 29.)

Relative Visual Comfort Evaluations Of Roadway Lighting

Charles H. Rex

J. S. Franklin

In terms of the number of people affected, visual comfort for roadway lighting may have even greater importance than visual comfort for interior lighting, great though this may be. Principles of visual comfort apply in outdoor situations as least equally with indoor visual tasks, and in some circumstances may be much more important. Seeing comfort as well as visibility is now recognized by high officials of the U. S. Bureau of Public Roads as an essential element in the safe use of streets and highways.[1]

Of particular significance are ratings in terms of relative visual comfort (designated discomfort glare) and relative visibility resulting from studies in other countries, for example, Netherlands, Great Britain and West Germany. The urgency of developing additional evaluation techniques for rating the relative comfort of roadway lighting systems has motivated several years of outdoor field testing of full-scale lighting systems, using the Guth Evaluator.[2]

Fig. 1 shows Evaluator relative visual comfort Ratings A and B at two driver-observer positions along a representative roadway lighting system. For comparison, Fig. 1 also shows computed relative visual comfort ratings for a similar roadway lighting system. The maximum and minimum computed ratings pertain to specific driver-observer positions with respect to the system luminaires and two designated Field Brightness conditions. The computation method has been presented[3,4,5] during the past year.

Authors: General Electric Co., Hendersonville, N. C.

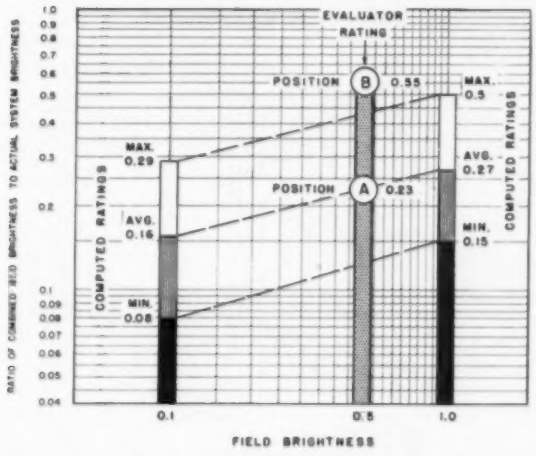


Figure 1. Evaluator relative visual comfort ratings for selected driver-observers at Position A and Position B on the test roadway are presented for comparison with computed ratings.[3] These ratings for similar roadway lighting systems are of similar magnitude even though different BCD methods are involved. Note increase in computed relative comfort ratings with the increase in Field Brightness.

The visual comfort ratings are relative to the motorist-observer brightness sensation which would be at BCD, the borderline between comfort and discomfort. The Evaluator BCD and the computed BCD and the comparison ratios are differentiated in the paper.

The Evaluator ratings were derived from a selective analysis of data produced by two years of outdoor field testing of a lighting system at Hendersonville, N. C. The test conditions are shown in Fig. 2. The selection of observer data was based on a BCD "population study" involving 50 people, conducted in the Photometric Laboratory at Hendersonville. The laboratory data provide a calibration on the observers used in the outdoor full-scale Evaluator studies. This exploration of observer judgment of BCD sensation was made using a five-sided environmental chamber, painted flat white on the inside. The BCD evaluations were made by means of the Guth Evaluator. Observers consisted of an all-white population of 52 people, 30 male and 22 female. Their origin represented a range of 21 degrees in north latitude; their ages range over a span of 40 years.

Fig. 3 shows the excellent agreement between the results of this work as compared with those obtained by previous investigations. Correlation tests for the relationship of BCD *vs* latitude of birthplace and of BCD *vs* age both had negative results.

The Guth Evaluator may be used in outdoor

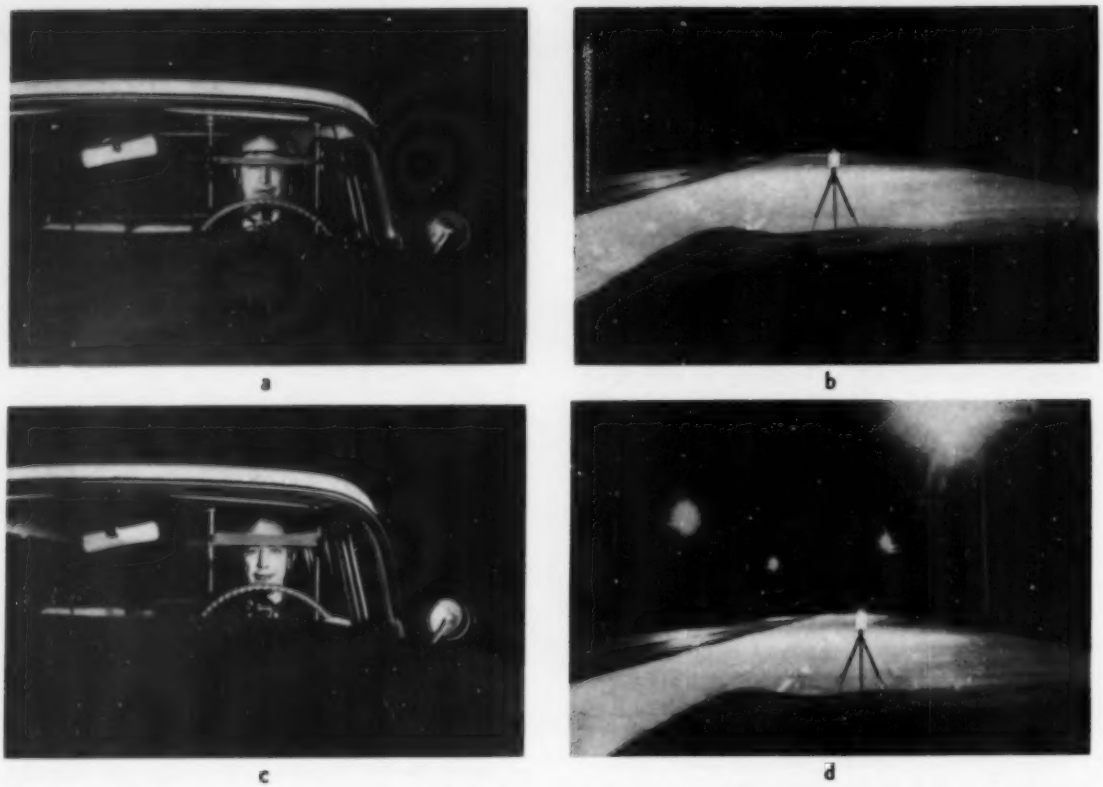


Figure 2. (a) Observer in test automobile with Evaluator headrest shield in the "down" position for appraisal of BCD brightness, $\bar{B}_L$. (b) Resultant cut-off of luminaires and observer's field of view. (c) Shield on Evaluator headrest rotated upward to expose observer's eyes to the combined brightness of the system luminaires. (d) Resultant exposure of luminaires in observer's field of view and Evaluator source at stand-by brightness reflected by mirror. For evaluation of system luminaire brightness, B_L, upper and lower test conditions are alternated automatically. Observer adjusts the brightness of the comparison source, B_L, on the line of sight for an impact sensation judged to be equivalent to the combined brightness of the luminaires.

full-scale tests to demonstrate and provide better understanding of the fundamentals involved in improving the relative visual comfort of roadway lighting. A driver-observer, sitting in an automobile, readily adjusts the brightness of the flashing comparison source to observe and readily appreciate the fact that the BCD brightness for a roadway lighting system increases with appreciably higher Field Brightness, including the brightness of the pavement. The Evaluator demonstrates that progress involves higher brightness at or near the pavement level with lower brightness up at the luminaires.

Because it provides guidance in making night driving easy and pleasant for drivers, this Evaluator is considered a valuable development and an essential step toward increasing the nighttime use of automotive transportation facilities.

1. "The Federal Role in Highway Safety," House Document No. 93, a report presented to the 86th Congress, 1st Session, February 27, 1959, by the U. S. Secretary of Commerce, stating results of the

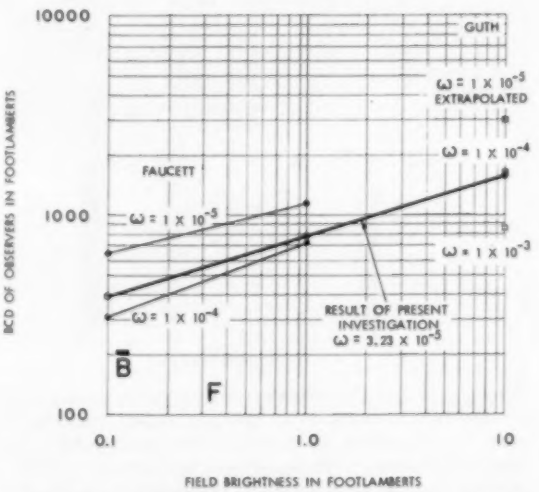


Figure 3. Results of BCD versus field brightness found in the present investigation as compared with the results of previous work by Faucett and Guth.

Highway Safety Study, Charles W. Prisk, Director, U. S. Bureau of Public Roads.
2. Guth, S. K. and McNelis, J. F.: "A Discomfort Glare Evaluator," ILLUMINATING ENGINEERING, Vol. LIV, No. 6, p. 398 (June 1959).
3. Rex, Charles, H.: "Computation of Relative Comfort and Relative Visibility Factor Ratings for Roadway Lighting," ILLUMINATING ENGINEERING, Vol. LIV, No. 5, p. 291 (May 1959).
4. Rex, Charles, H.: "Roadway Safety Lighting," a paper and report on behalf of the Institute of Traffic Engineers' Committee on Roadway Lighting, Annual Meeting, Institute of Traffic Engineers, November 13, 1958.
5. Rex, Charles, H.: "Ratings for Visual Benefits of Roadway Lighting," presented at the January 6, 1959 meeting of the Highway Research Board. Sponsored by the Research Board Committee on Night Visibility.

(Abstract of I.E.S. Conference Paper No. 28.)

An Improved Mercury Lamp Transformer for Maximum Regulator Loading on Series Circuits

M. E. Robertson

COST is one of the most important factors in street lighting; consequently, any developments in the direction of lower cost are of prime interest. This paper describes one way of getting more out of a constant current regulator by utilizing a new design series circuit insulating transformer which allows the usage of more mercury lamps per regulator. This is in the direction of lower cost lighting.

An economic comparison of multiple circuits to series circuits is not within the scope of this paper. A short comparison between straight series circuits and series circuits using isolating transformers is made. The advantages of using isolating transformers include increased safety, simplified control, lower cost luminaires, and the elimination of film cutouts and time delay relays.

The paper discusses the advantages of the cascade starting principle and explains how it can be utilized to allow heavier constant current regulator loadings with conventional large gap transformers. Minimum gap and the new optimum gap transformers are also described.

The available starting voltages have been determined by test. Curves are included showing peak and rms values as well as series loop current for starting the first lamp and the last lamp upon initial starting or after a momentary outage. These data for the optimum gap transformer are shown in Figs. 1 and 2.

In the practical loading of moving coil constant current regulators with mercury lamps and iso-

AUTHOR: Jefferson Electric Co., Bellwood, Ill.

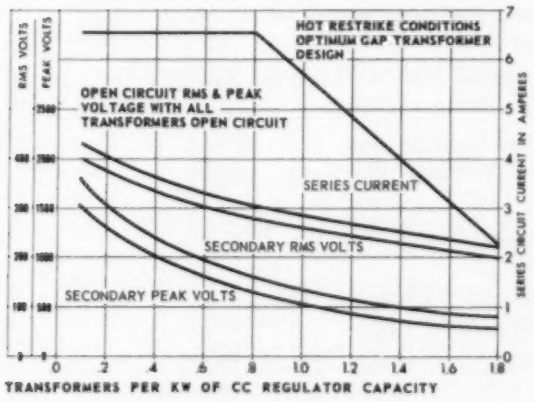


Figure 1.

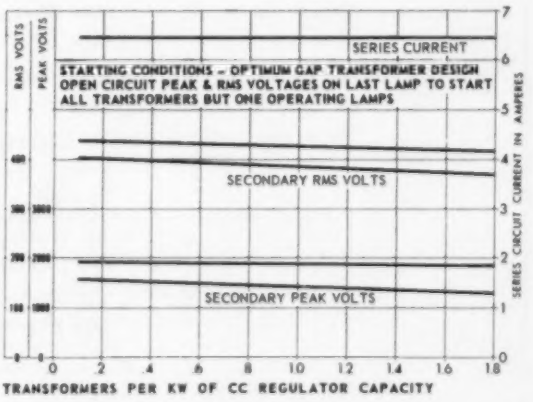

RMS VOLTS
PEAK VOLTS
SERIES CURRENT
STARTING CONDITIONS – OPTIMUM GAP TRANSFORMER DESIGN
OPEN CIRCUIT PEAK & RMS VOLTAGES ON LAST LAMP TO START
ALL TRANSFORMERS BUT ONE OPERATING LAMPS
SECONDARY RMS VOLTS
SECONDARY PEAK VOLTS
SERIES CIRCUIT CURRENT IN AMPERES
TRANSFORMERS PER KW OF CC REGULATOR CAPACITY

Figure 2.

TABLE I — Constant Current Regulator Loading for 50 Per Cent Impedance Regulators for 400-Watt H1 or H33 Mercury Lamps with Insulating Transformers. Allowance has been made for 10 Per Cent Lamp Outages and Six Watts Per Lamp Circuit Losses. Cascade Lamp Starting Is Utilized.

	Number of Lamps				
Regulator Rating	10	15	20	25	30
Large Gap Transformer (Factor .69)	14	22	29	36	43
Optimum Gap Transformer (Factor .62)	16	24	32	40	48

lating transformers, the limiting factor is not starting voltage if cascade starting is utilized, but rather the regulator capacity at the power factors encountered.

The results of the paper, a new recommended loading chart are shown in Table I. Here the advantages of cascade starting used with the conventional large gap insulating transformer can be seen. The new optimum gap unit shows a ten per cent advantage over the conventional unit. This chart is based upon an allowance of six watts per lamp circuit losses and ten per cent lamp outages. This allowance may be too great since many utilities and municipalities do a better job of maintaining their street lighting. An allowance of five per cent lamp outages or even one lamp per regulator would allow even heavier regulator loadings.

(Abstract of I.E.S. Conference Paper No. 25.)

Discussion of Conference Papers

Discussion of papers presented at the technical sessions of the San Francisco Conference should be submitted immediately for publication with the paper in ILLUMINATING ENGINEERING.

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One copy to Floyd W. Sell, Chairman, Papers Committee, Detroit Edison Co., 2000 Second Ave., Detroit 26, Mich.

One copy to the author of the paper.

One copy to the Discussion Organizer of the session. A listing of Discussion Organizers and their respective papers follows.

Paper No.	Discussion Organizer
1, 2, 3, 4, 5	John Haney, Crouse-Hinds Co., Wolf & 7th North Sts., Syracuse, N. Y.
6, 7, 8	O. F. Wenzler, Libbey-Owens-Ford Glass Co., 608 Madison Ave., Toledo 3, Ohio.
9, 10, 39	J. J. Neidhart, The Miller Co., Meriden, Conn.
12, 13, 15, 21, 32	A. W. Weeks, Champion Lamp Works, 330 Lynnway, Lynn, Mass.
17, 18, 20, 36, 38	George Gilleard, Curtis-AllBrite Lighting, Inc., 6135 W. 65th St., Chicago 38, Ill.
22, 23, 24	J. N. Robertson, Los Angeles Dept. of Water and Power, Box 3669 Terminal Annex, Los Angeles 54, Calif.
14, 16, 35, 37	A. B. Winters, Revere Electric Mfg. Co., 7420 Lehigh, Chicago 48, Ill.
25, 26, 27, 28, 29	R. E. Dahlin, Southern California Edison Co., Box 351, Los Angeles 53, Calif.
19, 30, 31, 33, 34	M. H. Kruger, Smitheraft Corp., Chelsea, Mass.

INSTALLATION AT LOUIS ALLIS CO., MILWAUKEE, WIS.

High Bay Industrial Lighting

LIGHTING OBJECTIVE: To provide general illumination in a high bay area used for rough assembly of electric motors.

GENERAL INFORMATION: The area shown above measures approximately 170 feet by 500 feet, with a ceiling height of 38 feet. Colors and reflectances are as follows:

ceiling	cream	50% RF	columns		
floor	brown	11% RF	upper portion	light green	60% RF
machine (typical)	gray	22% RF	lower portion	medium green	36% RF

INSTALLATION: One year after installation, average illumination level was 65 footcandles, 30 inches above floor. This level was provided by one Holophane catalog No. 640 ventilated, aluminum-covered, prismatic glass reflector unit for each 144 square feet of area. Each unit is suspended 28 feet above the floor from the underside of the purlins and is equipped with one 400-watt J-H1 improved-color mercury lamp.

Brightnesses at the end of the first year of operation, were as follows:

luminaire at 30°	750 fL	columns	
ceiling	11 fL	upper portion	22 fL
floor	6 fL	lower portion	6 fL
machine side	3 fL		

Lighting designed by Klug and Smith Co.; Electrical Contractor: Uihlein Electric Co.; both of Milwaukee, Wis.

Lighting data submitted by Edward H. Grieb, Wisconsin Sales Representative of the Holophane Co., Inc., Wauwatosa, Wis., as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Series XXIV
9-59

A.I.A. File No. 31

New Designations For Mercury Lamps

By WILLIAM S. TILL
MARIO PISCIOTTA

This article has been prepared in response to a suggestion of the IES Light Sources Committee, George A. Freeman, Chairman, and has been reviewed by that committee, as well as by the Task Group on Mercury Lamp Designations, C78.4, of the American Standards Association, June 1959.

MERCURY lamps have been given entirely new designations which are being used by the entire industry. Through the procedures of the American Standards Association, a uniform system of identification has been adopted, C78.380—1957, American Standard Method for the Designation of Mercury Lamps, replacing all the individual ordering abbreviations which previously existed. Users of mercury lamps may find it more convenient, with these new designations, to distinguish between the various types catalogued by different manufacturers, since lamps which are completely interchangeable, both electrically and physically, will have the same identification. Previously there have been as many as four or five distinctly different designations for lamps which were essentially the same.

The new ASA code consists of these basic parts:

(1) The letter "H"—to identify the lamps as belonging to the mercury group.

(2) A number or numbers — to identify the *electrical* characteristics of the lamp.

(3) Two letters—to identify the essential *physical* characteristics of the lamp. Although arbitrarily assigned, once established these letters retain the same meaning even if used on other lamps with different numbers.

(4) Color symbols—to identify the color characteristics of lamps differing from clear mercury lamps. Letters such as "C, W, S, Y, or X" will follow the rest of the designation, separated by a slant line (/).

Examples

H5KD—250-watt clear BT28 bulb mercury lamp, corresponding to specified electrical and physical characteristics, formerly identified by designation C-H5 or H250-A5 by different manufacturers.

H22KD—175-watt lamp similar to the above (note that the same letters, "KD," indicate that physical characteristics, *i.e.*, base, bulb, transparency, over-all length, light center length, etc., are the same for both the H5 and H22 types, within limits of normal tolerances.

AUTHORS: Westinghouse Electric Corp., Bloomfield, N. J., and American Standards Association, New York, N. Y., respectively.

H22KF/C—175-watt lamp having BT28 non-transparent outer bulb with color characteristics corresponding to use of letter C.

Explanation of Color Symbols

C—for phosphor-coated bulbs with about 8-10 per cent red component as ordinarily measured.

W or S—for similar lamps having about 5 per cent red component and higher light output.

Y—for yellow lamps.

X—for deluxe lamps.

These color symbols are assigned by the manufacturers, not by ASA. It is hoped that, at a later date, differences of opinion can be resolved and that the use of symbols such as "W" and "S" can be reduced to one common symbol. The only reason that color was not made a part of the lamp designation is that, as yet, there is no satisfactory standard method of measurement or established limits of color for mercury lamps. It is hoped, however, that this deficiency can be overcome, eventually, in order to bring "color" into the new code system.

Features of New Code

The new ASA code for designation of mercury lamps retains the most important features of the previous designations. These were the use of the letter "H" to identify the lamps as belonging to the mercury group and the use of a number to identify the electrical characteristics and, therefore, the type ballast with which the lamp must be used. The original mercury lamp designation system, which was used by most lamp manufacturers, consisted of an initial letter (A, B, C, etc.) which was assigned by each company as it developed new lamps in the same power rating (*i.e.*, A-H1, B-H1, etc.). The H1 originally meant "high intensity"

TABLE I—Mercury Lamp Designations
(Partial list—consult manufacturers' catalogs for other types and for complete description of electrical and physical characteristics.)

Lamp Watts	New ASA Designation*	Examples of Corresponding Old Designation	Outer Bulb Size and Description
100	H4GS	C-H4, H100-SP4	PAR38, spot
	H4JM	E-H4, H100-FL4	PAR38, flood
	H4AX	L-H4, H100-L4	PS25 or BT25, clear
	H4AC/C	M-H4, H100-M4	PS25 or BT25, phosphor-coated
	H4AC/W or S	M-H4/SW, S-H4	PS25 or BT25, phosphor-coated
175	H22KD**	A-H22, H175-A22	BT28, clear
	H22KF/C**	B-H22	BT28, phosphor-coated
	H22KF/W or S**	B-H22/SW, S-H22, H175-AW22	BT28, phosphor-coated
250	H5KD	C-H5, H250-A5	BT28, clear
	H5KF/C	D-H5, CC-H5, H250-J5	BT28, phosphor-coated
	H5KF/W or S	D-H5/SW, S-H5	BT28, phosphor-coated
400	H25DE	A-H1-WD, A-H1-H	BT24, clear
	H25HC	A-H1-T, H400-A1	T16, clear
	H1LS	E-H1, H400-E1	BT37, clear
	H1CD	E-H1-WD, H400-E1/WR, E-H1/WP	BT37, clear, hard glass
	H33-1CD	E-H1-LG	BT37, clear, hard glass
	H1LB/C	J-H1, H400-J1	BT37, phosphor-coated
	H1GL/W or S	J-H1/SW-WD, S-H1-WD, H400EW1/WR	BT37, phosphor-coated, hard glass
	H33-1GL/W or S	J-H1/SW-LG	BT37, phosphor-coated, hard glass
	H1LG/Y	J-H1/Y, G-H1, H400-JY1	BT37, phosphor-coated
	H33-1GL/X	J-H1-X	BT37, phosphor-coated, hard glass
	H1LK/W	P-H1/SW, KS-H1, H400-RW1	R57, R52, semi-reflector
	H33-1DS/C	P-H1-LG	R57, semi-reflector, hard glass
700	H18NA	A-H18-WD	BT46, clear
	H18ND/W or S	B-H18/SW-WD, S-H18-WD	BT46, phosphor-coated
1000	H15GV	A-H15-WD, H1000-A15/WR	BT56, clear, hard glass
	H15GW/C	B-H15-WD, C-H15-WD, H1000C15/WR	BT56, phosphor-coated, hard glass
	H15KY/W or S	D-H15/SW-WD, S-H15-WD, H1000RW15/WR	BT56, semi-reflector, hard glass
	H12GV**	A-H12-WD, H1000-A12/WR	BT56, clear, hard glass
	H12GW/C**	C-H12-WD, H1000-C12/WR, C-H12/WP	BT56, phosphor-coated, hard glass
	H12GW/X**	C-H12-X	BT56, phosphor-coated, hard glass
	H12KY/C**	D-H12-WD, H1000-RC12/WR, D-H12/WP	BT56, semi-reflector, hard glass
3000	H9FJ	A-H9, H3000-A9	T9½, clear

*Color symbols are selected by manufacturer.
**Supersede designations given in the Third Edition of the *IES Lighting Handbook*, in keeping with the principles of having the same letters identify the same physical characteristics, even among types that differ in electrical characteristics. For reference:

Lamp Watts	New ASA Designation	Former ASA Designation Shown in *IES Lighting Handbook*
175	H22KD	H22CA
	H22KF/C H22KF/W or S	H22CB
1000	H12GV	H12KN
	H12GW/C H12GW/X	H12KP
	H12KY/C	H12KS

but was quickly changed to H and 1. Then the H was said to refer to hydrargyrum, or mercury (Hg), and the 1 referred to certain electrical characteristics such as watts, volts, amperes, etc. These numbers were chosen in sequence, the 400-watt lamp having the number 1 assigned, and the low-voltage 250-watt, 85-watt, 100-watt, etc., having numbers 2, 3, 4, etc., respectively. Fortunately there was no serious disagreement throughout the industry in the choice of electrical numbers. With regard to letters, however, one company would use the letter "B" to identify a given lamp, while another company might use the letter "C." In addition, some companies assigned meaningful letters to identify lamps with reflectors (R), improved-color (C), weather resistance (WR), (WD), etc. Other companies included wattage in the lamp designation.

Advantages of a nationally applicable lamp designation system, such as that in effect through the auspices of ASA, are:

(1) Eliminates doubt in a consumer's mind as to interchangeabiltiy of a lamp with his existing lamp.

(2) Makes it easier for the consumer to compare the products of various manufacturers, since he can easily identify each type lamp.

(3) Makes it possible to mark fixtures for the particular lamp or lamp types they will operate.

(4) Simplifies identification and labeling of a distributor's stock.

(5) Avoids diffculties for manufacturers resulting from conflicting designations.

(6) Makes it possible for all concerned to learn a single code system rather than two or three.

The participating manufacturers, who were represented in a subcommittee operating under ASA Sectional Committee C78 on Electric Lamps, felt that it might be desirable to be able to indicate lamp wattage, lamp life, or other characteristics as part of the designation, and so provision was made for these features to be added at their discretion. On the other hand, they recognized that the designations should be kept as short as possible and that the system should be kept flexible, for easy

administration through a central clearing-house (ASA).

As an example of the flexibility of the new system, during 1958 a problem arose on how to identify new 400-watt quartz mercury lamps having improved performance. An ASA task group decided that, because of significant differences in starting voltage requirements, these lamps must be assigned a new electrical number, even though they would operate in all existing H1 sockets. It was agreed that they could be marked H33-1, which means that they are specially classed as H33 lamps but will operate in place of H1 lamps. The older H1 lamps, of course, will not carry the number 33 because they will not start as easily as H33 lamps; hence they are not interchangeable electrically. At low temperatures they would not light up when operated on H33 ballasts. However, since the types are the same in physical characteristics, the same letters are used for both to complete the designations, *e.g.*, H1CD, H33-1CD. As another example of the type of problem that had to be solved: the group decided to give the old glass-arc-tube H1 lamps a new electrical number, 25, because they found that there were distinct differences in certain characteristics such as minimum starting current. That is, the H25 lamps are not likely to warm up to full output during cold weather unless the starting current is at least 4.5 amperes, where 3.1 amperes is considered enough for H1 lamps.

With the constantly growing use of mercury lamps in all fields of lighting, the new mercury lamp designations, assigned in accordance with the American Standard Method of Designation of Mercury Lamps, C78.380-1957, will eliminate existing confusion and will provide a nationally applicable and convenient designation which may be used for both manufacturing and ordering purposes. A tabulation of some of the more important types of mercury lamps in their present new ASA and previous old ordering designations is presented in Table I.

Acoustics and Lighting in a Large Office

Problems encountered in re-lighting the customers' business office of the Northern States Power Co., Minneapolis, were: many unattractive ducts, pipes and conduits strewn over the ceiling and a comparatively low ceiling height, with large structural beams only 10 feet 5 inches from the floor. The room being quite large—75 by 125 feet—the low ceiling height precluded use of a luminous ceiling and it was thought that suspended fixtures might give a cluttered appearance.

A solution to these problems was found in a lighting system of 96-inch T12 slimline lamps placed between 12-inch deep perforated metal baffles with Fiberglas insulation. Baffles are painted in different pastel colors, blending with floor and wall colors, to break the monotony of the large area. Each lamp is covered lengthwise with a metal louver suspended below it. Louvers are 24 inches on center and provide 50 degrees shielding. Illumination level is approximately 115 footcandles and the acoustical treatment supplied by the baffles is an added benefit.

Photo and data courtesy of Louis J. Riegert, B.M.D. & R., Inc., Minneapolis, Minn.

Recommended Practice For Marine Lighting

Prepared by the Subcommittee on Marine Transportation of the Committee on Interior Lighting of Public Conveyances of the Illuminating Engineering Society

FOREWORD

These recommendations are the results of years of work of this committee, comprising representatives from government agencies, naval architects, shipbuilders and lamp and lighting equipment manufacturers. It is intended to represent the best modern practice of illuminating engineering as applied to the particular requirements on board ship.

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1. Introduction

1.1—*Scope* — These recommendations cover lighting for the principal living, dining and work areas found in merchant ships, as well as those tasks and areas, both exterior and interior, devoted to the navigational and operating functions necessary for the safe and effective performance of marine vessels.

Approved by the Council of the Illuminating Engineering Society, March 1958. A Transaction of the IES.

1.2—*Concept*—(a) Since a merchant ship is in essence a self-propelled floating community, it has, to a greater or lesser degree depending on the type of vessel, living spaces, work areas and tasks, much like those existing ashore. The illumination requirements, therefore, are similar to those for residential, hotel, industrial and, to a lesser extent, outdoor applications on land. There are, as well, some requirements peculiar to ship spaces and operation. All are influenced, however, by more serious weight, size and power requirements and limitations than exist ashore.

(b) In addition, there are special problems of electrical hazard, corrosion, vulnerability in case of fire, and space limitations due to the generally low headroom. There may also be difficulties resulting from vibration and roll and pitch of the ship. Special lighting is required for navigation, lifeboat handling, signalling and other marine functions.

(c) For detailed aspects relating to areas and tasks not covered in these recommendations, the *IES Lighting Handbook* and other IES illumination publications should be consulted.

1.3—*Regulatory Body Requirements and Other Standards*—(a) The requirements for safety of life for ships of American registry are established by the U.S. Coast Guard in their Electrical Engineering Regulations, 46 CFR, Parts 110 to 113, inclusive (Publication CG-259). The complete electrical system, including lighting, must comply with these regulations and be approved by the U.S. Coast Guard before the vessel can be placed in service under American Registry.

(b) The American Bureau of Shipping establishes the requirements and certifies the ship as being eligible for insurance issued by members of the Marine Insurance Underwriters.

(c) The American Institute of Electrical Engineers Standard No. 45 defines recommended practice for electric installations on shipboard.

2. Objectives of Shipboard Lighting Design

2.1—*General* — The objective of shipboard lighting is to provide for safety and well-being of passengers and crew, to provide adequate and comfortable illumination for the task involved, and for the efficient operation of the ship. It is recommended that an illumination survey be made of the completed installation in accordance with the requirements of section 2.3 herein to insure that the above objectives have been achieved.

2.2—*Illumination Levels* — **(a)** Table I lists most of the spaces normally encountered on board ship and the recommended minimum illumination levels for the tasks in these spaces. The values listed for the spaces represent minimum average values of the general illumination, measured without daylight or light supplied by supplementary units such as mirror lights, berth lights, gauge lights, etc., but including all units normally contributing to the general illumination such as wall brackets, floor lamps and table lamps. They are based on the safety, utilitarian and decorative characteristics of the areas concerned and have been established, as far as possible, to accord with the IES standards and recommendations for comparable tasks and areas in home, office, industrial and recreational spaces on land. Illumination of tasks and areas not covered in this table should be lighted in accordance with the levels of other recom-

TABLE I—Recommended Illumination Levels.

	Currently Recommended Illumination* Footcandles
LIVING AREAS	
Staterooms	
Crew	5**
Officers	5**
Passengers	5**
Berth, on reading plane	15
Mirrors, at face	50
Baths	
Crew	5
Public	5
Officers	5
Passengers	5
Mirrors, at face	50
Passageways	5
Stair foyers, passenger	10
Stairs	
Passenger	10
Crew	5
Entrance, passenger	10‡
Lounges, passenger and officers	10**†
Recreation rooms, crew	20
On tables	30
Dining room, passengers	10†
Mess room, officers and crew	10
On tables	15
Libraries	10
For reading	30
Smoking rooms	5**†
Enclosed promenades, along inboard bulkhead for reading	10
Barber shop and beauty parlor	20
On subject	50
Cocktail lounges	5†
Bars	5†
Ballrooms	5†
Swimming pools, indoor beaches	10 (Also underwater lights and sun lamps)
Shopping areas	20**
Theatres	
During show	0.1
Intermission	5
Gymnasiums	20
Hospital	
Operating room	50**
Dental room	30**
Dispensary	30**
Wards	5**
Doctor's office	20**
Waiting room	10**†
Radio room, passenger foyer	10**†
Passenger counter, purser's office	20
NAVIGATING AREAS	
Wheelhouse (not used underway)	5
Chart room	10
On chart table	50
Radar room	5
Gyro room	5
Radio room	10**
Ship's offices	20
On desks and work tables	50
For bookkeeping and auditing	50
Log room	10
On desk	50
SERVICE AREAS	
Galley	20**
Laundry	15**
Pantry	15**
Sculleries	15**
Food preparation	20**
Food storage (non-refrigeration)	5
Refrigerated spaces (ship's stores)	5
Butcher shop	15**
Print shop	30**
Tailor shop	50**
Post offices	20**
Lockers	3
Telephone exchange	10**
Storerooms	5
OPERATING AREAS	
Engine rooms (working areas)	10**
Boiler rooms (working areas)	10**
Fan rooms	5
Motor generator rooms (cargo handling)	5
Generator and switchboard rooms	10
Windlass rooms	5
Switchboards, vertical illumination	
At top	30
Three feet above deck	10
Steering gear room	5
Pump room	1
Gauge and control boards (vertical illumination)	
On gauges	30
Shaft alley	3
Dry cargo holds (permanent luminaire)	1**
Refrigerated cargo loading and unloading	3**
Work shops	20
On work	50
Cargo hatches	
Over hatch area	5
Adjacent deck area	3

*Minimum on the task at all times.
**Supplementary lighting should be provided in this space to produce the higher levels of lighting required for specific seeing tasks involved.
†In public areas such as lounges, ballrooms, bars, smoking rooms and dining rooms, the footcandle values may vary widely, depending upon the atmosphere desired, the decorative scheme and the use made of the room.
‡The installation should be such that the level of illumination can be increased to at least 40 footcandles for daytime embarkation.

mendations of the Illuminating Engineering Society.

(b) Proper placement of the luminaires to incorporate the features of effective lighting design is assumed. For example, luminaires provided for illumination of gauges, instruments, switchboards, control panels, etc., should be engineered and located to eliminate reflected glare from the gauge and meter glass.

(c) In public areas such as lounges, ballrooms, bars and dining rooms, the footcandle values may vary considerably from those listed, depending upon the decorative scheme and the atmosphere desired.

2.3—*Method of Measuring Illumination Levels*

2.3.1—*Photometer*—A photocell type of illumination meter (equipped with a filter, so that the instrument approximates the spectral response of the eye) and a cosine correction device should be used to take photometric measurements. Portable visual photometers may also be used. If no filter is provided appropriate factors (available from the manufacturer) should be used to correct the measured values for each type of light encountered. A cell-type instrument, unless hermetically sealed, should not be used in temperatures lower than 60F, if practicable. The cell should be exposed to the approximate level of illumination to be measured for at least five minutes if it has been kept in the dark for several hours, or to each new level of illumination that varies ±10 footcandles from that previously measured. Cell-type instruments have no provision for field calibration other than a zero reading correction. They should be checked frequently against a master instrument of known calibration or returned to a reliable laboratory at regular intervals for calibration.

2.3.2—*Compartments to be Surveyed*—(a) Combine compartments of similar nature into groups, in accordance

with 2.3.4.1. Select one or more compartments from each group for a survey, the results of which are representative of the entire group. Compartments that cannot be grouped should be surveyed individually.

(b) The average illumination in all compartments, such as lockers, etc., of less than 25 square feet in area, which have only one luminaire installed and have identical footcandle requirements, should be represented by a survey taken in one compartment only.

2.3.3—*Selection of Illumination Measurement Stations*

2.3.3.1—*General Illumination* — (a) All readings for general illumination should be taken on a horizontal plane 30 inches above the finished deck. This plane should be considered the working plane.

(b) Selection of stations in the horizontal plane for measurement in any compartment should be governed by one of the following two methods of measurement:

Method #1 — (i) Compartments of irregular area or containing luminaires placed in asymmetrical arrangement are included in this group, which comprises the major portion of the ship. Compartments falling in this class should be divided into areas of two-foot or four-foot squares and one reading should be taken in each square. The readings should then be averaged. Due to the natures of stowage, furnishings, etc., it may be impracticable to survey an entire compartment. For instance, compartments such as storerooms should be surveyed in the aisle spaces surrounding the bins only. In compartments containing work surfaces such as desks, counters, work benches, sinks, tables, etc., which may be as much as six inches above the 30-inch working plane, readings should be taken on these surfaces as part of the working plane of the compartment.

(ii) In general, in compartments of 100 square feet in area or less, the two-foot square subdivision should be used for taking survey readings.

(iii) In general, in compartments of over 100 square feet in area, the four-foot square subdivision should be used for taking survey readings.

(iv) When conducting the survey, the subdivision of any compartment should be so arranged that the number of readings taken between luminaires should be equal to or greater than those taken directly under luminaires.

Method #2 — Compartments which have regular area and contain luminaires placed in symmetrical arrangement are included in this group. Stations selected for measurement in these compartments should conform to current requirements of Illuminating Engineering Society recommendations for field measurements (*IES Lighting Handbook*).

2.3.3.2—*Detail Illumination* — Readings for detail illumination should be taken in a manner that will reflect the average illumination on the working surface of the equipment selected. Readings should be taken on horizontal surfaces of desks, tables, etc. Measurements for mirrors should be taken approximately 16 inches away from the surface of the mirror, with the cell in a position facing and parallel to the mirror. For berths and bunks, measurements should be taken at a point 12 inches above the top of the mattress, 24 inches from the headboard and at an angle of 45 degrees.

2.3.3.3—*General*—(a) General illumination measurements in any compartment should be taken with local lights, such as berth, mirror, desk, and any other lights that add to the task illumination, extinguished. However, decorative lighting units such as wall brackets, table lamps, etc., should be energized while taking general illumination survey readings.

(b) Detail illumination measurements should be taken with all lighting units in the compartment energized.

2.3.4—*Supplementary Precautions for Taking Survey*

2.3.4.1—*Compartments Selected* — Compartments selected for a specific group should be essentially similar in characteristics, such as size, color of paint, type of luminaire, mounting heights and watts per square foot.

2.3.4.2—*Extraneous Light* — Daylight and light from other compartments should be excluded.

2.3.4.3—*Luminaires* — All luminaires should be checked to insure that they are clean. New lamps of the proper type, voltage, and wattage should be installed in all lighting units. Incandescent lamps should be seasoned for six hours and fluorescent lamps for 100 hours, at labeled voltage. All fluorescent units should be placed in operation at least one-half hour immediately before taking readings, except that totally enclosed and gasketed units should be placed in operation two hours before the tests.

2.3.5 — *General Appraisal* — **(a)** The lighting units for general illumination should, in general, provide:

(i) Proper distribution of illumination over the area which they should cover. (See Section 6.)

(ii) Proper illumination without objectionable glare either directly from the luminaire or reflected from the working surfaces. (See Section 5.3.)

(iii) No objectionable shadows should be cast on the work by obstruction or by personnel as they perform their normal activities.

(iv) Uniform illumination throughout the space, free of contrasting light and dark areas when all luminaires for general illumination are in use.

(b) Any deficiencies to the foregoing should be noted during the survey in order that corrections may be made.

2.3.6—*Operating Voltage*—The lighting system should be energized from the ship's generators. Normal voltage should be maintained on the switchboard lighting buses. The voltage should be maintained constant at all times.

2.3.7—*Shadows*—Personnel should be careful to avoid casting shadows on the sensitive plate of the meter, and should wear dark clothing so that their reflections will not cause inaccurate readings.

2.3.8—*Tabulation of Data*—The final results should be recorded on special plans prepared for the purpose. These plans should be made up from general arrangement plans plus additional sketches as may be necessary. Plans should contain only the compartments which are to be surveyed in accordance with Section 2.3.2 above. Plans should show pertinent arrangement of furniture. Readings for general illumination should be indicated where they were taken and an average footcandle value should be shown for each compartment. Detail illumination readings for each item selected, such as berths, mirrors, and desks, should be recorded on these plans. Plans should also indicate the recommended footcandle requirements for each compartment.

2.4—*Livable Environment* — In order to achieve a comfortable, livable environment, attention must also be given to the reflectances of finishes, the effect of the light source upon the color of finishes and decorations, and the minimizing of brightness ratios (see 5.3.2).

2.4.1—*Interior Finishes and Reflectances* — **(a)** A well-designed lighting system cannot be planned independently of the color and character of the surfaces it is to illuminate. The effect obtained depends largely upon the way the large surfaces within an area reflect and absorb the light. Thus, bulkheads, overheads, decks and major equipment become an integral part of the lighting design. If large areas have a high or glossy finish, specular mirror-like reflections of light sources and luminaires may be distracting or even uncomfortable. Matte finishes are, therefore, desirable. The following ranges of reflectances are recommended:

Area	Per Cent Reflectance
Overheads	60-90
Bulkheads	35-60
Decks	15-35
Office-Type Furniture	26-44
Industrial-Type Machinery	25-30

(b) Reflectance values at the higher end of the recommended ranges for overheads and bulkheads are more important in utility and working spaces where efficiency of the lighting system is of greater significance. However, bulkhead reflectances appreciably greater than 60 per cent may create problems of excessive bulkhead brightness where luminaires are placed near the bulkheads or where extensive bulkhead lighting methods are employed. In any area in which the major luminaires depend largely on reflections from the overhead for their effective performance, the reflectance of the overhead should be 80 per cent or more. Since sections of the deck may form a considerable portion of the immediate surroundings for many visual tasks, the middle and higher deck reflectances are encouraged. With lower reflectances than recommended, it is very difficult to attain comfortable brightness ratios.

2.4.2—*Effect of Light on Color*—The appearance of colored surfaces undergoes change with both the amount of light and spectral (color) quality of the light. Low illumination levels result in a grayed, less colorful appearance. Dissatisfaction with color schemes often stems from the fact that they are selected under high levels of daylight and then when viewed under the much lower levels of electric light appear dull by comparison and seem to be a different color. The color changes may be due also to the differences in color composition or quality of light between daylighting and electric light sources. Both vary over a wide range from a reddish or warm white to bluish or cool white. A higher proportion of blue and green is present in daylight and in fluorescent lamps than in the light from incandescent filament lamps. In the latter, the proportion of yellow-red is greater. Colors should be selected under the illumination levels and light sources contemplated.

3. Selection of Light Sources

3.1—*Choice of Incandescent Filament or Fluorescent Lamps* — **(a)** The choice between incandescent filament and fluorescent lamps is influenced by the physical and brightness characteristics of the two sources, by the relative installation costs, and by the operating load. The incandescent filament lamp is the more concentrated, small high brightness source and its light is readily controlled by relatively small lighting units. For comfortable brightness, filament lamps require the use of adequate shielding, directional control, or highly diffusing material. The fluorescent lamp is a larger-area low brightness source, and its shielding requirements are less than those of the filament lamp for equivalent luminaire brightness. Fluorescent lamps are much more efficient than filament lamps when used on a-c circuits, producing from 30 to over 50 lumens per watt including ballast, as compared with 10 to 17 lumens per watt for most incandescent filament lamps.

(b) The higher luminous efficacy of the fluorescent lamp makes possible higher illumination levels for better seeing conditions with a given wattage. Other things being equal, there is no difference in visual effectiveness between incandescent filament and fluorescent light. However, when the illumination level is low (5-15 footcandles), fluorescent lighting may have a less pleasing psychological effect on some individuals than the same footcandle level of incandescent light. This appears to be particularly so if the fluorescent sources are of the "cool" white types. Fluorescent lamps produce considerably less radiant heat than incandescent filament lamps for a given illumination level and their life is six or more times as long, when used on a-c circuits, depending on lamp type and operating conditions. The lower heat radiation of a fluorescent lighting system for a given illumination level is a considerable advantage in air-conditioned spaces.

(c) Fluorescent lamps may have some disadvantages in some locations on ships due to their longer length, the large luminaires required, generally slower starting of sizes and types permitted by the regulations regarding open circuit voltages of ballasts, more difficult storage of spare lamps and lower power factor. However, rapid start ballasts for two 40-watt fluorescent lamps which meet the open circuit voltage requirements, and provide rapid starting, are available. In order to reduce power losses in the ship's wiring, the use of high power factor ballasts, wherever practicable, is recommended. When used on d-c circuits, fluorescent lamps require additional auxiliary equipment which reduces the lumen output per watt.

3.2—*Light Source Color* — The color quality of light may be a factor favorable to either source, depending upon individual preference and the color of the surroundings. A space may be lighted satisfactorily with either type of source, or the two can be combined successfully in the same space. Fluorescent lamps are available with about the same apparent color of light as that provided by filament lamps. Also, there are types which approximate daylight. Thus, if fluorescent lamps are to be used, and if the overall atmosphere of warmth associated with filament lamps is the objective, a warm white lamp should be selected. These lamps make colored surfaces appear much the same as they would under incandescent filament light. If an atmosphere more nearly related to daylight is sought, a cool white fluorescent lamp should be used. In addition to the regular warm and cool fluorescent lamps there are also types, both warm and cool, which offer greatly im-

proved color rendition. This better color rendition is obtained with some loss in light output. The cool lamp of this type often creates a fresher atmosphere. Both improved-color lamps more nearly bring out all colors in fabrics, as well as in foods and complexions.

4. Shipboard Lighting Distribution Systems

4.1—*General* — While shipboard lighting distribution system requirements are clearly defined by the regulatory bodies, it is considered that the following information, included for ready reference, will be of interest to the lighting engineer.

4.2—*Types of Systems*—(a) In general, the lighting aboard ship consists of either two or three distribution systems: general lighting, temporary emergency lighting and final emergency lighting.

(b) The general lighting system is supplied from the ship's power system, furnishes the major portion of the illumination, and is installed on all ships.

(c) Both a temporary emergency lighting system and final emergency lighting system are generally installed on passenger vessels, while a single emergency lighting system is generally installed on cargo vessels.

(d) The temporary emergency lighting system is supplied from the emergency batteries and provides adequate lighting properly located for safety and escape and for avoidance of panic under emergency conditions, during the period between failure of the general lighting power supply and the energizing of the final emergency supply. Under normal conditions this system is supplied from the ship's power supply and forms a part of the general lighting system.

(e) The final emergency lighting system is usually supplied from a diesel-driven generator. It provides illumination for safety and escape, operation of vital services and illumination for restoration of the main power supply. Under normal conditions this system is supplied from the ship's power supply and forms a part of the general lighting system.

(f) The emergency lighting system for cargo vessels may be supplied from a diesel-driven generator or from a storage battery and provides illumination for safety, escape, operation of vital services and restoration of main power supply. Under normal conditions this system is supplied from the ship's power supply and forms a part of the general lighting system.

4.3—*Voltages and Distribution*—(a) American marine lighting systems in general may be considered to be either three-wire 115/230 volts d-c or 450/120 volts, three-phase, 60-cycle a-c. In the former, the three-wire feeders supply lighting distribution panels from which two-wire 115-volt branch circuits are run to supply the lighting installation. In the latter, the 450-volt ship's service supply is transformed to 120-volt, three-phase feeders at either the main generator distribution switchboard or, in large vessels where appreciable weight savings can be obtained, at load centers or primary stations. From the point of transformation three-phase feeders are run to the lighting distribution panels having three-phase main buses and single-phase branch circuits outgoing to the lighting installation.

(b) There are some installations using other voltages such as two-wire, 120-volt, d-c and 230-volt, three-phase, 60-cycle a-c. However, they constitute only a very small percentage of the total and the systems described in paragraph (a) above, are considered "standard practice" in America. European systems include 230-volt, two-wire d-c and 220-volt, three-phase a-c.

(c) Standard generator switchboard bus voltages in use today are:

Direct Current	Alternating Current
120	120
240	230
	450

In designing a lighting distribution system utilizing any of the foregoing bus voltages, it should be remembered that for the most economical and efficient lighting installation, socket voltage for incandescent systems should be lamp design voltage. For fluorescent installations, ballast voltage should be the design center voltage, *i.e.*, for 110-125-volt ballasts the most efficient circuit voltage is 118 volts. Corresponding design center voltages are recommended for higher voltage fluorescent ballasts.

(d) It is considered that lighting system cable sizes should be selected on the basis of (1) current carrying capacity, (2) providing, as nearly as practicable, lamp design voltage at the socket for incandescent installations and design center voltage at the ballast in fluorescent installations, and (3) at no point exceeding three per cent voltage drop in the lighting circuit at the most remote outlet.

(e) In the past, incandescent filament lamps for marine installations have been considered standard at 115 volts. Fluorescent lamp installations at other voltages such as 450/260, or even 450 volts, particularly in public space coves, troffers, etc., offer such advantages in weight savings, air-conditioning tonnage, copper savings, panel sizes, etc., as to become the preferable distribution potentials for fluorescent lighting installations. In some locations 118-volt fluorescent lamp ballasts are preferred.

(f) In the design of any lighting distribution system, segregation from the power system should be made as close to the generator as is practicable in order to insure a minimum of incandescent filament lamp flicker caused by large motor starting inrush currents. With fluorescent lighting, the use of high power factor ballasts, wherever possible, is recommended.

(g) While the use of a quick starting type of fluorescent lamp and ballast would be preferable, the U. S. Coast Guard Electrical Engineering Regulations provide that an auto-transformer used as part of a ballast which raises the voltage to more than 300 volts, shall be supplied only by a grounded system and that electric discharge lamps designed for an open-circuit voltage in excess of 700 volts shall not be used. This, at the present time, limits the use of instant starting lamps and ballasts to ships having a grounded electrical system.

5. Lighting Design

5.1—*General*—All of the general requirements for good lighting apply aboard ship.

5.2—*Proper Illumination Levels for Safety and Function* — The recommended illumination levels for various areas on shipboard appear in Section 2.2.

5.3—*Good Quality of Illumination for Visual Comfort*

5.3.1—*Brightness and Glare* — The proper control of brightness is essen-

tial to good lighting design. Without control, brightness becomes glare, interfering with, instead of aiding seeing. High brightness and high brightness ratios within the field of view produce difficult seeing conditions and, under prolonged viewing, generally result in complaints of eye fatigue and discomfort. Objectionable brightnesses may reach the eye directly or indirectly through reflections from shiny surfaces. Glare can be reduced by: (1) reorientation of seating arrangement and work surfaces, (2) relocating luminaires, (3) covering or modifying reflecting surfaces (such as employing light, non-glossy finishes) and (4) controlling light at its source with good luminaire design.

5.3.2—*Brightness Ratios* — In order that the details of a seeing task be visible, there must be a brightness or color difference in relation to the immediate background. Visibility is usually maximum when the brightness or color contrast of details with the adjacent area is greatest. Though high contrast provides best visibility within the task, high brightness differences become objectionable in the area surrounding the task and in more remote portions of the field of view. However, lack of brightness diversity in the surrounding areas, an ideal critical seeing environment, may create an atmosphere which is sometimes considered monotonous and drab. Monotony can often be relieved by the judicious use of color. Suggested maximum brightness ratios of 1 to 1/3 between a visual task and its adjacent surroundings are suggested by various IES recommended practices (for Office, School and Library Lighting). (See Table II.) Between the task and more remote darker areas, a maximum of 1 to 1/10 is suggested. (1 to 10 between task and more remote lighter surfaces.) In general, for prolonged critical seeing, and for best comfort, the lower the brightness ratios the better. The application of light, non-glossy finishes to all the major room and work surfaces helps to create a comfortable balance of brightnesses in the environment. The location and spacing of the luminaires in an area should be such that deep, harsh shadows and dark areas are eliminated.

5.3.3—*Luminaire Brightness*—Low luminaire brightness is also fundamental to good illumination design. Low luminaire brightness results in lower brightness ratios between the luminaire and the adjacent walls or ceiling area for all except totally indirect luminaires or systems. In general, the average brightness of the total luminous area of a luminaire should not exceed 500 footlamberts, and ratios of 20 to 1 or less between the luminous portion of a luminaire and the visually adjacent surfaces are acceptable. Lighting designers, architects, and decorators must collaborate to obtain these results in an efficient lighting system and to create attractive, comfortable and well-arranged lighting systems. Due to low head room, ventilation ducts, piping and structural members, careful preliminary planning is needed to assure adequate ceiling space for effective lighting in living and public areas.

TABLE II—Brightness Ratios.

To achieve a comfortable brightness balance, it is desirable to limit brightness ratios between areas of appreciable size from normal viewpoints as follows:

1 to 1/3	Between task and adjacent surroundings
1 to 1/10	Between task and more remote darker surfaces
1 to 10	Between task and more remote lighter surfaces
20 to 1	Between luminaires and surfaces adjacent to them
40 to 1	Anywhere within the normal field of view

5.4—***Reflectances***—It is especially desirable on shipboard that relatively light colors of finishes of a high reflectance, and luminaire designs of high efficiency be used. The bulkheads and the usually low overheads should be treated with colors of high reflectance, and glossy finishes should be avoided. In the working spaces the higher of the reflectances given in 2.4.1 should be used. In living and public spaces, the higher reflectances are also recommended, but the selection should be tempered by the interior decorations and atmosphere desired. For indirect or cove lighting, the ceilings should be painted white or off-white with a minimum reflectance of 80 per cent. Special matte finishes should be used to avoid specular reflection of the light sources.

5.5—***Switching***—Lighting in large public spaces, machinery spaces and cargo holds should be controlled directly from the lighting distribution panelboards. Lighting in staterooms, baths, offices, mess rooms, crew and officers' recreation rooms and other smaller spaces should be controlled by switches at the doors. Spaces having more than one entrance should have a switch at each door. Switches should be watertight or non-watertight as required by the location. Where watertight luminaires are used the switches should also be watertight. Switches controlling lamps in spaces in which explosive gases or mixtures may normally be expected to accumulate must be located outside such spaces.

5.6—***Luminaires*** — Watertight luminaires should be used in corrosive, damp or wet locations.* Where explosive gases or mixtures may normally be expected to accumulate the luminaires should be located outside the compartment or must be explosion-proof type.

5.7—***Receptacles*** — Plug-in receptacles should be provided throughout the ship for the use of portable lamps and other lighting equipment not permanently connected to the ship's power supply. All receptacles operating at a potential of 100 volts or more are required by the regulations to be three-pole grounded types. Receptacles in the living and public spaces may be of the non-watertight type, while those in the working and storage spaces should be of the watertight type.

5.8—***Other Considerations***—**(a)** Particular attention should be given to consideration of weight, size and power consumption of the lighting equipment and system. The materials used should be suitable for use in the corrosive atmosphere encountered at sea. Care must be exercised to minimize corrosion and electrolytic action caused by contact of dissimilar metals.

(b) With fluorescent lamps, lampholders or other auxiliary equipment and devices designed to reduce lamp vibrations and eliminate lamp drop-out should be used.

6. Interior Lighting

6.1—***General***—Although lighting in the interior of a ship involves spaces similar to many of those encountered on land, due to low ceiling heights, space limitations and the requirements for watertight, guarded or explosion-proof luminaires in certain locations, there are some differences necessary in the design and application of luminaires from those encountered on land.

*See Coast Guard Electrical Engineering Regulations.

Figure 1. Stateroom. General illumination is from fluorescent cove equipped with 40-watt T-12 rapid-start lamps (ballasts modified for marine service). Aperture in the cove bottom, at the center portion of the mirror, provides illumination for grooming. Incandescent portable lamps at the head of each bed serve as berth lights.

6.2—*Living and Public Spaces*

6.2.1—*Staterooms* — Uniform general illumination, supplemented by berth lights, mirror lights, table lamps, floor lamps, desk lights, bracket lights, etc., to suit the arrangement of furniture and the decorative scheme, should be provided. See Figs. 1 and 2. Ceiling luminaires are usually provided in crew staterooms, but are sometimes omitted in passenger staterooms when the recommended illumination level is supplied by floor, table or bracket lights. When lavatory mirrors are installed in staterooms, one or more mirror lights should be provided (one of which usually contains a receptacle for electric razors, etc.).

6.2.2—*Baths, Toilet-and-Showers*—General illumination should be provided by one or more ceiling luminaires (depending upon the size of the room and the size of available luminaires). One or more mirror lights should be provided for each mirror. In small spaces, where the mirror light(s) provides the recommended general illumination, the ceiling light may be omitted. See Fig. 2.

6.2.3—*Passageways, Stair Foyers, Stairs*—These spaces should be uniformly illuminated by luminaires installed overhead, in the corner between the bulkhead and the overhead, or in other suitable locations. See Figs. 3 and 4. Care should be exercised in locating the luminaires to illuminate cross passages, stairs, room numbers, etc. Some of the lamps in these areas should be supplied from the emergency lighting system(s) to provide for safety and escape in an emergency, the number depending on luminaire locations (there should be no areas without some light) and the requirements of the United States Coast Guard.

6.2.4—*Passenger Entrances*—As these are the first spaces on board the ship

Figure 2. Stateroom and toilet and shower space. Surface-mounted incandescent luminaire, controlled from room entrance, provides general illumination in this stateroom. The dressing alcove (at right) is provided with illumination for make-up from table lamps at each side of the mirror. General illumination in the toilet and shower area at left is by a fluorescent bulkhead luminaire installed over the mirror.

Figure 3. (above). Stairs lighted by vertical coves. Each side of the architectural recesses is equipped with fluorescent lamps.

Figure 4. (right). Passageway illumination is provided by fluorescent luminaires built into a continuous soffit on one corner of the overhead.

seen by the passenger, particular attention should be paid to the quality of illumination provided (Section 5.3). The lighting system should provide a general level of 10 footcandles with provisions for increasing the level to 40 footcandles for daytime embarkation. Emergency lighting should be provided to enable escape (see 6.2.3).

6.2.5—*Passengers' and Officers' Dining Room, Passengers' Lounges, Libraries, Smoking Rooms, Cocktail Lounges, Bars, Ballrooms*—These are all public spaces and the principles of lighting involved are the same as for similar land installations. See Figs. 5 through 9 and the *IES Lighting Handbook*. Emergency lighting should be provided to enable escape (see 6.2.3 above).

6.2.6—*Barber Shop and Beauty Parlor* —The general illumination level should be 20 footcandles. Particular attention should be given to providing 50 footcandles on the customer's head.

6.2.7—*Shopping Areas* — The principles of modern store lighting, as outlined in the *IES Recommended Practice for Lighting Stores and Other Merchandising Areas*, should be applied in these areas. Twenty footcandles is the recommended illumination level. Supplementary lighting should be provided to produce the higher levels required for the specific seeing tasks involved. Emergency lighting should be provided to enable escape (see 6.2.3 above).

6.2.8—*Theatres* — Theatres should be lighted to provide 0.1 footcandles during the show and 5 footcandles during intermission. On board ship, the theatre is often used for several purposes: motion pictures, live shows, assemblies, etc. The lighting should be sufficiently flexible to provide illumination for all purposes required. Stage lighting, spotlighting, exit lighting and aisle lighting

Figure 5. In First Class dining room general illumination in both the center and wing areas is from coves equipped with incandescent lamps. Spotlights incorporated into the lower coves illuminate the sculpture on the bulkhead in the background. Supplementary lighting at each table is provided by a portable lamp supplied through a receptacle on the table's pedestal.

Figure 6. Incandescent coves in the center of the room and around the perimeter provide the general illumination in this cabin lounge. Locally-controlled bulkhead-mounted lamps are used for supplementary lighting. The cove lighting is controlled from distribution panels.

Figure 7. Officers' dining room with two-lamp fluorescent luminaires mounted on the overhead to provide uniform illumination throughout the room. Three-way switch control is provided at the entrances to the room.

Figure 8. Cocktail lounge. Fluorescent lamps installed in a circular cove around the perimeter of this room provide decorative illumination on the draperies. General illumination is from the incandescent downlights which are recessed in the overhead. Lighting is controlled from the distribution panel.

Figure 9. Main ballroom. General illumination is provided by circular coves equipped with incandescent lamps. Valances equipped with incandescent lamps provide lighting on the perimeter drapes. Lamps may be dimmed by motor-operated transformer-type dimmers controlled from both orchestra platform and control board.

Figure 10. Downlights and vertical coves equipped with incandescent lamps provide the general illumination in this ship's theatre. Lighting is controlled by motor-operated transformer-type dimmers from the lighting control station in the stage wings and from the operating booth at the rear of theatre. Five 500-watt floodlights are installed in an athwartship cove just forward of the vertical coves visible in the photograph.

should be provided. Exit lights should be connected to the emergency system.

6.2.9—*Gymnasium* — The gymnasium on board ship is usually more of the nature of an exercise room than of a gymnasium. It usually contains chest weights, mechanical horses, mechanical bicycles, rowing machines, electric vibrators, punching (striking) bags, a small portable mat, or other similar equipment. Twenty footcandles of general illumination should be provided.

6.2.10—*Passengers' Counter, Purser's Office*—This is the counter at which passengers receive stateroom assignments and transact other business with the ship. Both the counter and the space behind it should be attractively illuminated to 20 footcandles.

6.2.11—*Radio Room, Passenger Foyer* —The general illumination should be 10 footcandles in this area. Also, since this is the space where passengers go to write and send radio messages, supplementary lighting should be furnished to provide 50 footcandles for writing messages.

6.2.12—*Swimming Pools* — Swimming pools should be provided with underwater lighting as well as overhead lighting for the pool and the surrounding area. Emergency lighting should be provided for safety and escape (see 6.2.3 above).

6.2.13—*Hospital*

6.2.13.1 — *Operating Room* — Fifty footcandles of general illumination should be provided. A special operating light (or lights) should be provided for the operating table. All electrical equipment installed less than five feet above the deck must be explosion-proof. Further requirements for the electrical installation are contained in the *Recommended Safe Practice for Hospital Operating Rooms*, published by the National Fire Protection Association. The operating light and at least one general lighting luminaire should be supplied from the emergency lighting system.

6.2.13.2—*Dental Room*—Thirty footcandles of general illumination should be provided. A special dental light should also be provided. At least one lamp should be supplied from the emergency lighting system.

6.2.13.3—*Doctor's Office and Dispensary* — Twenty footcandles of general illumination, plus special examination lights, treatment lights, etc., should be provided.

6.2.13.4—*Waiting Room*—Ten footcandles of general lighting plus lighting for casual reading should be provided in a manner to suit the decorative scheme of the room.

6.2.13.5—*Wards*—In addition to the general lighting, a berth light should be provided for each berth. If an attendant's desk is installed, a desk light should be provided. At least one lamp in a general lighting unit should be supplied from the emergency lighting system.

6.2.14—*Recreation Room — Crew* — General lighting is required to provide illumination for card playing, reading or writing. Desk lights should be installed at all writing desks. At least one general lighting lamp should be supplied from the emergency lighting system.

6.2.15—*Special Lights* — Exit lights, supplied from the emergency lighting system, should be installed to lead personnel to the open decks and the lifeboats. Illuminated designation and directional signs should be installed as required.

6.3—*Ship's Offices and Navigation Spaces*

6.3.1—*Wheelhouse*—During nighttime operation of the ship, the wheelhouse must be in complete darkness, except for necessary instrument lights. General lighting should be provided for cleaning and maintenance purposes only. Passageway lights, which would interfere with navigation when a door to the wheelhouse is opened, should be controlled by a door-operated switch. In order not to interfere with dark adaptation of the eyes of the personnel on duty, instruments should be illuminated by red lights of wavelengths not less than 600 millimicrons and brightness not greater than 0.1 footlambert.

6.3.2—*Chart Room*—General lighting (10 footcandles) should be provided by ceiling luminaires. Adjustable chart table lamps, fitted with red filters, should be installed to provide 50 footcandles. A lamp should be installed for illumination of the chronometers and should be controlled by a momentary contact switch. The chart table lamp should be supplied from the emergency lighting system.

6.3.3—*Radar Room and Gyro Room*—This space or these spaces should be provided with general lighting of five footcandles.

I.E.S. LIGHTING DATA SHEET 23-13

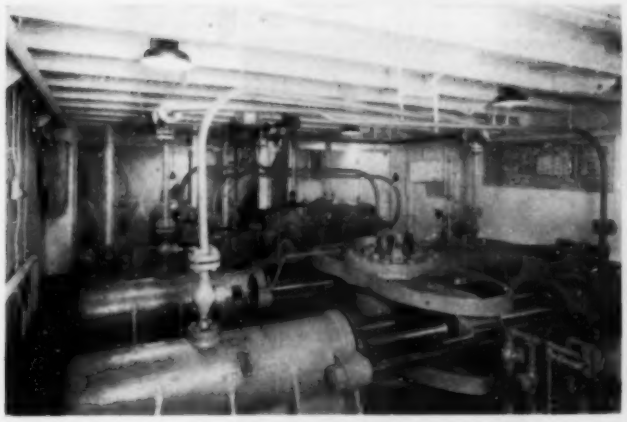

Figure 11. (above). Steering gear room. General illumination is by watertight luminaires in reflectors. These are controlled by a watertight switch at the entrance. Watertight receptacles are provided for the use of portable supplementary units used for illumination of servicing and maintenance equipment.

Figure 12. (right). Lighting for nighttime use of swimming pool area is from railing-mounted floodlighting luminaires located on the deck above. Portable festoon lights have been provided to add "party" atmosphere. Note stack lighting from additional floodlights.

6.3.4—*Radio Room*—The radio room should be illuminated to 10 footcandles by ceiling luminaires, all of which should be supplied from the emergency lighting system. Additional supplementary lighting should be provided for the specific visual tasks.

6.3.5—*Log Desks*—Log desks should be equipped with a desk lamp to provide a level of 50 footcandles.

6.4—*Service Spaces*—Careful attention should be paid to the quality of illumination in galleys, shops and other service spaces. Reflected glare and high brightness ratios should be avoided. The general illumination should be provided by ceiling luminaires with a concentration over benches and working surfaces; supplementary detail lighting should be provided at griddles and range tops, sewing machines and other points where specific tasks are performed.

6.5—*Operating Spaces* — Machinery spaces, steering gear rooms (see Fig. 11) and other ship operating spaces should be provided with general illumination by means of luminaires installed so that piping and other interferences do not obstruct light. The general lighting should be supplemented by detail lighting of gages, switchboards and other points where meter readings or specific functions require higher levels of illumination.

7. Exterior Lighting

7.1—*General Deck Lighting* — Outside lighting of decks should be by means of watertight deck and bulkhead luminaires. Protective guards should be provided except in certain passenger areas such as passengers' promenades where it is desirable to achieve a certain decorative effect. In certain areas, such as those below, levels of illumination in excess of that required for safe night passage should be provided.

7.2—*Cargo Handling* — Modern ships are usually fitted with permanent lighting installations in the cargo holds, and receptacles are normally located at the hatches for use with portable cargo clusters. In addition to the foregoing, floodlighting of the deck area in the vicinity of cargo hatches is recommended. This may be accomplished by the use of 500-watt projector type floodlights suitably located on the ship's structure. At least two such floodlights should be provided at each hatch.

7.3—*Sports Deck* — Where illumination is desired for nighttime sports activities, projector type floodlights suitably located to illuminate the game areas are recommended. See Fig. 12.

7.4—*Lifeboat Launching* — Projector type floodlights (500-watt considered suitable) should be provided at each lifeboat for launching. The location of the light should be such that it can be trained on the boat or the boat gear during launching operations.

7.5—*Stack Lighting*—Where stack floodlighting is desired, 500-watt projector type floodlights equipped with focusing adjustment are recommended. They should be provided in sufficient quantity and located to insure an even light distribution on the entire stack, except when special effects are desired. See Fig. 12.

7.6—*Navigation Lights*—Navigation lights should conform to the "Rules of the Road" and should be installed to conform to the governing rules for the waters in which the vessel is to navigate.

7.7—*Searchlights* — A 1000-watt searchlight installed on the top of the wheelhouse and operable from within the wheelhouse should be provided for navigational purposes. In addition, two signalling searchlights, equipped with manually-operated shutters, should be provided, one port and one starboard on the bridge wings.

A.I.A. File No. 31f

INSTALLATION AT DELAWARE AVENUE MEDICAL CENTER, BUFFALO, N. Y.

Lighting a Building's Sign

LIGHTING OBJECTIVE: To illuminate a building's identification sign in a dignified but attention-compelling manner.

GENERAL INFORMATION: This building, located in a residential area, is approximately 50 feet wide. The illuminated facade is of light cream brick (70% RF), with a seven-foot high panel of blue terra cotta (30% RF) which acts as a background for the stainless steel sign letters.

INSTALLATION: Five NuArt Lighting & Manufacturing Co. (Salt Lake City, Utah) catalog No. NASL-105-96-RS units are mounted 18 inches above ground, 48 inches out from the building. Each of the eight-foot long units is equipped with one 96-inch T-12, 1500 ma cool white VHO rapid-start lamp. Each unit is also provided with plastic covers, neoprene socket boots, and three weep holes. All units are aimed at a 45-degree angle with the vertical.

After approximately five months of use the illumination was 65 fc at 48 inches above ground. At a seven-foot height the illumination was 35 fc. Brightnesses were as follows: brick at 48-inch height, 40 fL; terra cotta panel at 48-inch height, 20 fL; and stainless steel letters, 14 fL. It is reported that the sign can be easily read at a 150-foot distance.

Lighting designed by Frey Electric Construction Co., 225 French St., Buffalo, N. Y.

Lighting data submitted by the Niagara Mohawk Power Corp., Buffalo, N. Y., as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Series XXIV
9-59

A.I.A. File No. 31f

Illuminating Engineering Nomenclature And Photometric Standards

Prepared by the Nomenclature Committee of the Illuminating Engineering Society

Preface

Since the publication of ASA Z7.1-1942 "Illuminating Engineering Nomenclature and Photometric Standards," the Nomenclature Committee has been developing or revising segments of the Standard with the aim of eventually having a complete revision. As these segments, usually whole sections, are revised by the Committee, they are sent to Council for approval and publication.

This report presents terms and tables in Section 05. which are to replace those of the same number published in ILLUMINATING ENGINEERING, Vol., LII, No. 11, pp. 600-608 (November 1957). It also presents a new Section 25 which is to replace the section of the same number in the 1942 Standard.

NOMENCLATURE COMMITTEE

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Section 05. Photometric Quantities

05.005. LIGHT: For the purposes of illuminating engineering, *light* is visually evaluated radiant energy.

Light is psychophysical, neither purely physical nor purely psychological. Light is not synonymous with radiant energy, however restricted, nor is it merely sensation. In a general, nonspecialized sense light is the aspect of radiant energy of which a human observer is aware through the visual sensations which arise from the stimulation of the retina of the eye.

The present basis for the engineering evaluation of light consists of the color-mixture data $\bar{x}$, $\bar{y}$, $\bar{z}$ adopted in 1931 by the International Commission on Illumination. These data include the spectral luminous efficiency[1] data adopted in 1924 by the CIE. (See 05.100 and 05.101.)

05.015. LUMEN, lm:* The lumen is the unit of luminous flux. It is equal to the flux through a unit solid angle (steradian) from a uniform point source of one candela (candle), or to the flux on a unit surface all points of which are at unit distance from a uniform point source of one candela.

For some purposes the kilolumen, equal to 1000 lumens, is a convenient unit.

05.025. CANDELA (CANDLE), c: The candela (formerly candle) is the unit of luminous intensity. One candela is defined as $^1/_{60}$th of the luminous intensity of one square centimeter of projected area of a blackbody radiator operating at the temperature of solidification of platinum. Values for standards having other spectral distributions are derived by the use of accepted spectral luminous efficiency data.[1] (See 05.100 and 05.101.)

From 1909 until the introduction of the present photometric system on January 1, 1948, the unit of luminous intensity in the United States, as well as in France and Great Britain, was the "international candle" which was maintained by a group of carbon-filament vacuum lamps. For the present unit as defined above, the internationally accepted term is *candela*. The difference between the candela and the old international candle is so small that only measurements of high precision are affected. (See National Bureau of Standards Letter Circular LC864.)

05.030. CANDLEPOWER, $I = dF/d\omega$; abbreviation, cp: Candlepower is luminous intensity expressed in candelas (candles).

05.040. FOOTCANDLE, fc:* The footcandle is the unit of illumination when the foot is taken as the unit of length. It is the illumination on a surface one square foot in area on which there is a uniformly distributed flux of one lumen, or the illumination produced at a surface all points of which are at a distance of one foot from a uniform point source of one candela (candle).

05.045. LUX, lx:* The lux is the practical unit of illumination in the metric system, and is equivalent to the "metercandle." It is the illumination on a surface one square meter in area on which there is a uniformly distributed flux of one lumen, or the illumination produced at a surface all points of which are at a distance of one meter from a uniform point source of one candela (candle).

05.070. UNITS OF PHOTOMETRIC BRIGHTNESS (LUMINANCE): Photometric brightness (luminance) of a surface in a specified direction may be expressed in luminous intensity per unit area of surface.

A typical unit in this system is the candela (candle) per square inch.

Photometric brightness (luminance) of a surface in a specified direction may also be expressed in terms of the number of lumens per unit area which would be emitted by the surface if the brightness in all directions within the hemisphere on the side of the surface being considered were the same as the brightness in the specified direction.

A typical unit in this system is the footlambert, equivalent to one lumen per square foot.

Approved by the Council of the Illuminating Engineering Society, February 1959, except for 05.005, 05.095, 05.100, 05.101, 05.102, Table I(a) and Table I(b) which were approved March 1958. Terms 05.025, 05.105 and 25.7 approved March 1958 with further revisions approved February 1959. A Transaction of the I.E.S.

[1]The term *spectral luminous efficiency* replaces the former *relative luminosity* or *relative luminosity factor*.

*For terms bearing this reference, the definitions given are substantially equivalent to definitions adopted by the International Commission on Illumination.

This method of specifying photometric brightness is equivalent to stating the number of lumens which would be emitted if the surface were replaced by a perfectly diffusing surface with a photometric brightness in all directions within the hemisphere equal to the photometric brightness of the actual surface in the direction specified. In practice no surface follows exactly the cosine formula of emission or reflection; hence the photometric brightness (luminance) is not uniform but varies with the angle from which it is viewed.

The average photometric brightness (average luminance) of a surface may be expressed in terms of the total lumens actually emitted from the surface per unit area. Average photometric brightness (average luminance) specified in this way is identical in magnitude with luminous emittance (05.016).

In general, the concept of average photometric brightness (average luminance) is useful only when the photometric brightness (luminance) is reasonably uniform throughout a very wide angle of observation and over a large area of the surface considered. It has the advantage that it can be readily computed for reflecting surfaces by multiplying the incident luminous flux density (illumination) by the luminous reflectance of the surface. For a transmitting body it can be computed by multiplying the incident luminous flux density by the luminous transmittance of the body.

05.075. STILB, sb:* The stilb is a unit of photometric brightness (luminance) equal to one candela (candle) per square centimeter.

The name stilb has been adopted by the International Commission on Illumination and is commonly used in European publications. In America the preferred practice is to use self-explanatory terms such as candela per square inch and candela per square centimeter.

05.080. LAMBERT, L: The lambert is a unit of photometric brightness (luminance) equal to $1/\pi$ candela (candle) per square centimeter, and, therefore, is equal to the uniform photometric brightness (luminance) of a perfectly diffusing surface emitting or reflecting light at the rate of one lumen per square centimeter.

The lambert is also the average photometric brightness (luminance) of any surface emitting or reflecting light at the rate of one lumen per square centimeter. For the general case the average must take account of variation of photometric brightness (luminance) with angle of observation; also of its variation from point to point on the surface considered.

05.085. FOOTLAMBERT, fL: The footlambert is a unit of photometric brightness (luminance) equal to $1/\pi$ candela (candle) per square foot, or to the uniform photometric brightness (luminance) of a perfectly diffusing surface emitting or reflecting light at the rate of one lumen per square foot, or to the average photometric brightness (luminance) of any surface emitting or reflecting light at that rate.

The average photometric brightness (luminance) of any reflecting surface in footlamberts is, therefore, the product of the illumination in footcandles by the luminous reflectance of the surface.

The footlambert is the same as the "apparent footcandle."

05.095. SPECTRAL LUMINOUS EFFICACY[2] OF RADIANT FLUX, $K_\lambda = F_\lambda / P_\lambda$: Spectral luminous efficacy of radiant flux (see 10.015) is the ratio of the luminous flux at a given wavelength to the radiant flux at that wavelength. It is expressed in lumens per watt.

05.100. SPECTRAL LUMINOUS EFFICIENCY OF RADIANT FLUX[1]: Spectral luminous efficiency of radiant flux is the ratio of the luminous efficacy for a given wavelength to the value at the wavelength of maximum luminous efficacy. It is dimensionless.

05.101. VALUES OF SPECTRAL LUMINOUS EFFICIENCY[1] FOR PHOTOPIC VISION, V_λ: The values of spectral luminous efficiency given at 10-millimicron intervals in column two of Table I(a) were provisionally adopted by the International Commission on Illumination in 1924 and were adopted in 1933 by the International Committee on Weights and Measures as the basis for establishment of photometric standards of types differing from the primary standard in spectral distribution of radiant flux. The intermediate values given in other columns of Table I have been interpolated.

These standard values of spectral luminous efficiency were determined by observations with a small photometric field having a moderately high photometric brightness (luminance), and photometric evaluations based upon them consequently do not apply exactly to other conditions of observation.

05.102. VALUES OF SPECTRAL LUMINOUS EFFICIENCY[1] FOR SCOTOPIC VISION, V'_λ: The values of spectral luminous efficiency given at 10-millimicron intervals in Table I(b) were provisionally adopted by the International Commission on Illumination in 1951.

These values of spectral luminous efficiency were determined by observations by young dark-adapted observers using extrafoveal vision at near-threshold photometric brightness (luminance).

05.103. LUMINOUS EFFICACY OF RADIANT FLUX: The luminous efficacy of radiant flux is the ratio of the total luminous flux to the total radiant flux. It is expressed in lumens per watt.

Although luminous efficacy of radiant flux is expressed in lumens per watt of the radiant flux, the luminous efficacy of a practical source of light is based upon the power *supplied to* the source rather than the radiant flux *from* the source (see 25.7).

The reciprocal of the maximum luminous efficacy of radiant flux is sometimes called "mechanical equivalent of light;" that is, the watts per lumen at the wavelength of maximum luminous efficacy. The most probable value is 0.00147 watt per lumen, corresponding to 680 lumens per watt as the maximum possible luminous efficacy. These values are based on the candela (candle) as defined in 05.025, on the 1947 International Temperature Scale by using Planck's equation with $c_2 = 1.438$ cm deg K, $c_1 = 3.741 \times 10^{-12}$ watt cm^2, and 2042K as the temperature of freezing platinum, and on the standard CIE photopic spectral luminous efficiency values given in Table I(a). If the standard CIE scotopic spectral luminous efficiency values given in Table I(b) are used, the maximum luminous efficacy is 1746 "scotopic" lumens per watt.

Section 25. Light Sources

25.1 LAMP: Lamp is a generic term for a man-made source of light. By extension, the term is also used to denote sources that radiate in regions of the spectrum adjacent to the visible.

*For terms bearing this reference, the definitions given are substantially equivalent to definitions adopted by the International Commission on Illumination.

[2] Formerly luminosity factor.

TABLE I(a)—Photopic Spectral Luminous Efficiency Values.
(Unity at Wavelength of Maximum Luminosity)

λ in mμ	Standard Values	Values interpolated at intervals of one millimicron								
		1	2	3	4	5	6	7	8	9
380	0.00004	0.000045	0.000049	0.000054	0.000059	0.000064	0.000071	0.000080	0.000090	0.000104
390	.00012	.000138	.000155	.000173	.000193	.000215	.000241	.000272	.000308	.000350
400	.0004	.00045	.00049	.00054	.00059	.00064	.00071	.00080	.00090	.00104
410	.0012	.00138	.00156	.00174	.00195	.00218	.00244	.00274	.00310	.00352
420	.0040	.00455	.00515	.00581	.00651	.00726	.00806	.00889	.00976	.01066
430	.0116	.01257	.01358	.01463	.01571	.01684	.01800	.01920	.02043	.02170
440	.023	.0243	.0257	.0270	.0284	.0298	.0313	.0329	.0345	.0362
450	.038	.0399	.0418	.0438	.0459	.0480	.0502	.0525	.0549	.0574
460	.060	.0627	.0654	.0681	.0709	.0739	.0769	.0802	.0836	.0872
470	.091	.0950	.0992	.1035	.1080	.1126	.1175	.1225	.1278	.1333
480	.139	.1448	.1507	.1567	.1629	.1693	.1761	.1833	.1909	.1991
490	.208	.2173	.2270	.2371	.2476	.2586	.2701	.2823	.2951	.3087
500	.323	.3382	.3544	.3714	.3890	.4073	.4259	.4450	.4642	.4836
510	.503	.5229	.5436	.5648	.5865	.6082	.6299	.6511	.6717	.6914
520	.710	.7277	.7449	.7615	.7776	.7932	.8082	.8225	.8363	.8495
530	.862	.8739	.8851	.8956	.9056	.9149	.9238	.9320	.9398	.9471
540	.954	.9604	.9661	.9713	.9760	.9803	.9840	.9873	.9902	.9928
550	.995	.9969	.9983	.9994	1.0000	1.0002	1.0001	.9995	.9984	.9969
560	.995	.9926	.9898	.9865	.9828	.9786	.9741	.9691	.9638	.9581
570	.952	.9455	.9386	.9312	.9235	.9154	.9069	.8981	.8890	.8796
580	.870	.8600	.8496	.8388	.8277	.8163	.8046	.7928	.7809	.7690
590	.757	.7449	.7327	.7202	.7076	.6949	.6822	.6694	.6565	.6437
600	.631	.6182	.6054	.5926	.5797	.5668	.5539	.5410	.5282	.5156
610	.503	.4905	.4781	.4658	.4535	.4412	.4291	.4170	.4049	.3929
620	.381	.3690	.3570	.3449	.3329	.3210	.3092	.2977	.2864	.2755
630	.265	.2548	.2450	.2354	.2261	.2170	.2082	.1996	.1912	.1830
640	.175	.1672	.1596	.1523	.1452	.1382	.1316	.1251	.1188	.1128
650	.107	.1014	.0961	.0910	.0862	.0816	.0771	.0729	.0688	.0648
660	.061	.0574	.0539	.0506	.0475	.0446	.0418	.0391	.0366	.0343
670	.032	.0299	.0280	.0263	.0247	.0232	.0219	.0206	.0194	.0182
680	.017	.01585	.01477	.01376	.01281	.01192	.01108	.01030	.00956	.00886
690	.0082	.00759	.00705	.00656	.00612	.00572	.00536	.00503	.00471	.00440
700	.0041	.00381	.00355	.00332	.00310	.00291	.00273	.00256	.00241	.00225
710	.0021	.001954	.001821	.001699	.001587	.001483	.001387	.001297	.001212	.001130
720	.00105	.000975	.000907	.000845	.000788	.000736	.000688	.000644	.000601	.000560
730	.00052	.000482	.000447	.000415	.000387	.000360	.000335	.000313	.000291	.000270
740	.00025	.000231	.000214	.000198	.000185	.000172	.000160	.000149	.000139	.000130
750	.00012	.000111	.000103	.000096	.000090	.000084	.000078	.000074	.000069	.000064
760	.00006	.000056	.000052	.000048	.000045	.000042	.000039	.000037	.000035	.000032

A lighting unit consisting of a lamp with shade, reflector, enclosing globe, housing, or other accessories is also called a "lamp." In such cases, in order to distinguish between the assembled unit and the light source within it, the latter is often called a "bulb" or "tube," if it is electrically powered. (See also 30.035, Luminaire.*)

25.3.2 FLUORESCENCE: Fluorescence is the emission of light as the result of, and only during, the absorption of radiation of shorter wavelengths.

25.3.3 PHOSPHORESCENCE: Phosphorescence is the emission of light as the result of the absorption of radiation, and continuing for a noticeable length of time after excitation.

25.3.4 ELECTROLUMINESCENCE: Electroluminescence is the emission of light from a phosphor excited by an electromagnetic field.

25.4 INCANDESCENT FILAMENT LAMP: An incandescent filament lamp is a lamp in which light is produced by a filament heated to incandescence by an electric current.

25.2 INCANDESCENCE: Incandescence is the self-emission of radiant energy in the visible spectrum due to the thermal excitation of atoms or molecules.

TABLE I(b)—Scotopic Spectral Luminous Efficiency Values. (Unity at Wavelength of Maximum Luminous Efficiency.)

λ in mμ	Relative Value	λ in mμ	Relative Value
380	0.000589	590	0.0655
390	.002209	600	.03315
400	.00929	610	.01593
410	.03484	620	.00737
420	.0966	630	.003335
430	.1998	640	.001497
440	.3281	650	.000677
450	.455	660	.0003129
460	.567	670	.0001480
470	.676	680	.0000715
480	.793	690	.00003533
490	.904	700	.00001780
500	.982	710	.00000914
510	.997	720	.00000478
520	.935	730	.000002546
530	.811	740	.000001379
540	.650	750	.000000760
550	.481	760	.000000425
560	.3288	770	.0000002413
570	.2076	780	.0000001390
580	.1212		

25.3 LUMINESCENCE: Luminescence is any emission of light not ascribable directly to incandescence.

25.3.1 GASEOUS DISCHARGE: Gaseous discharge is the emission of light from gas atoms excited by an electric current.

25.3.1.1 ARC DISCHARGE: An arc discharge is an electric discharge characterized by high cathode current densities and a low voltage drop at the cathode.

25.3.1.2 GLOW DISCHARGE: A glow discharge is an electric discharge characterized by a low, approximately constant, current density at the cathode, low cathode temperature, and a high, approximately constant, voltage drop.

25.5 ELECTRIC-DISCHARGE LAMP: An electric-discharge lamp is a lamp in which light (or radiant energy near the visible spectrum) is produced by the passage of an electric current through a vapor or a gas.

(a) Electric-discharge lamps may be named after the filling gas or vapor which is responsible for the major portion of the radiation; *i.e.*, mercury

*"Illuminating Engineering Nomenclature and Photometric Standards," ASA Z 7.1-1942.

lamps, sodium lamps, neon lamps, argon lamps, etc.

(b) A second method of designating electric-discharge lamps is by physical dimensions or operating parameters; *i.e.*, short-arc lamps, high-pressure lamps, low-pressure lamps, etc.

(c) A third method of designating electric-discharge lamps is by their applications; in addition to lamps for illumination there are photochemical lamps, bactericidal lamps, black-light lamps, sun lamps, etc.

25.5.1 HOT-CATHODE LAMP: A hot-cathode lamp is an electric-discharge lamp whose mode of operation is that of an arc discharge. The cathodes may be heated by the discharge or by external means.

25.5.2 COLD-CATHODE LAMP: A cold-cathode lamp is an electric-discharge lamp whose mode of operation is that of a glow discharge, and which has electrodes so spaced that most of the light comes from the positive column between them.

25.5.3 GLOW LAMP: A glow lamp is an electric-discharge lamp whose mode of operation is that of a glow discharge, and in which light is generated in the space close to the electrodes.

25.5.4 FLUORESCENT LAMP: A fluorescent lamp is a low-pressure mercury electric-discharge lamp in which a fluorescing coating ("phosphor") transforms some of the ultraviolet energy generated by the discharge into light.

25.5.4.1 PREHEAT FLUORESCENT LAMP: A preheat fluorescent lamp is a fluorescent lamp designed for operation in a circuit requiring a manual or automatic starting switch to preheat the electrodes in order to start the arc.

25.5.4.2 INSTANT-START FLUORESCENT LAMP: An instant-start fluorescent lamp is a fluorescent lamp designed for starting by a high voltage without preheating of the electrodes.

25.5.4.3 RAPID-START FLUORESCENT LAMP: A rapid-start fluorescent lamp is a fluorescent lamp designed for operation with a ballast that provides a low-voltage winding for preheating the electrodes and initiating the arc without a starting switch or the application of high voltage.

25.5.5 FLUORESCENT-MERCURY LAMP: A fluorescent-mercury lamp is an electric-discharge lamp having a high-pressure mercury arc in an arc tube, and an outer envelope coated with a fluorescing substance ("phosphor") which transforms some of the ultraviolet energy generated by the arc into light.

25.5.6 CARBON-ARC LAMP: A carbon-arc lamp is an electric-discharge lamp employing an arc discharge between carbon electrodes. One or more of these electrodes may have cores of special chemicals which contribute importantly to the radiation.

25.5.7 BALLAST: A ballast is a device used with an electric-discharge lamp to obtain the necessary circuit conditions for starting and operating.

25.5.8 STARTER: A starter is a device used in conjunction with a ballast for the purpose of starting an electric-discharge lamp.

25.6 PHOTOFLASH LAMP: A photoflash lamp is a lamp in which combustible metal or other solid material is burned in an oxidizing atmosphere to produce light of high intensity and short duration for photographic purposes.

25.7 LUMINOUS EFFICACY (OF A SOURCE OF LIGHT): The efficacy of a source of light is the ratio of the total luminous flux emitted to the total lamp power input. Power may be expressed in watts or in thermal units consumed per unit time.

25.8 LIGHT CENTER: The light center of a lamp is the center of the smallest sphere that would completely contain the light-emitting element of the lamp.

25.9 LIGHT CENTER LENGTH: The light center length of a lamp is the distance from the light center to a specified reference point on the lamp.

Know Your Society in 1959-1960

Special features in the October issue of ILLUMINATING ENGINEERING will be two vital parts of the Society's structure for the new administrative year. Pictures of all IES officers, National and Local, are scheduled for this issue, as well as lists of Committees, as far as appointed, for 1959-1960. Watch for this handy reference material on the inside workings of IES.

LIGHTING NEWS

IES Elects Eight Fellows

On the recommendations of the Board of Fellows, the Council of IES elected eight members to the grade of Fellow. This unanimous action was taken at the June 18 meeting of Council. The new Fellows are:

Richard D. Bradley, Technical Director, Research Department, Day-Brite Lighting Inc., St. Louis, Mo.; St. Louis Section.

Technical committee activity, papers presented before National Technical Conferences and published in IE, research and development in photometry, glare evaluation and specifications for finishes of materials—these are, in main, Mr. Bradley's contributions to the lighting industry and, ultimately, to the lighting consumer.

Mr. Bradley is active in committee work, not only in IES but also for NEMA and ASA. He is currently serving as Chairman of the IES Institutions Committee and as a member of the School, Testing Procedures and Maintenance Committees. Previously he has served on many other of the Society technical committees. He is Chairman of the subcommittee on a Practical Guide to Photometry. He is Chairman of the Ballast Heating Committee of NEMA and is a member of the ASA Ballast Committee, C82.

He is the author or co-author of some twelve papers published in IE, many of them also presented before national or regional conferences. He speaks frequently at local Section and Chapter meetings.

Among his rather diverse accomplishments in research and development can be listed a photometric laboratory using snychronized linear recording, a corrosion-resisting finish for use on steel under severe conditions, a method of determining the hiding power of plastics or other diffusing or refracting materials and a "Glare Range" technique of direct glare evaluation. He has also developed and constructed a thermal laboratory for the study of thermal effects of ballasts and sources.

George W. Clark, Manager of Engineering, Fixtures, Sylvania Lighting Products Inc., Wheeling, West Va.; Pittsburgh Section.

One of Mr. Clark's most original contributions to the lighting field has been his stimulation of interest in the esthetic and psychological aspects of lighting, particularly with respect to periodic changes in color and arrangement. He has been associated to a great extent with the use of plastics for lighting equipment. By working closely with manufacturers of plastics materials, by giving talks and preparing articles relating to their use in lighting equipment, he has been instrumental in establishing an understanding of both their capabilities and limitations. He has worked with the SPI-IES-NEMA group in relation to the establishment of standards for use of plastics in lighting equipment.

Mr. Clark has served the Society in both technical and non-technical ways. He has been a member or chairman of many IES technical committees, currently is Chairman of the Committee for Lighting Design Practice and a member of the Roadway and the Handbook Revision Committees. He has presented two papers before IES National Conferences and has done original work in the fields of fluorescent lighting for television production, calculations for extended area lighting and acoustics and lighting.

When in Washington, D. C., with the Potomac Electric Power Co., he was Chairman of the Capital Section of IES, in 1950-1951. He was Chairman of the Executive Committee for the 1951 National Technical Conference.

Berlon C. Cooper, Associate Editor, *Electrical Construction and Maintenance*, McGraw-Hill Publishing Co., New York, N. Y.; New York Section.

Practically all phases of applied illuminating engineering have, at one time or another, been Mr. Cooper's concern. He began his career in the industry as a sales manager with Curtis Lighting Inc., at which time he developed many new application techniques. He later became a lamp and lighting specialist for the General Electric Supply Corp., where he helped to further the use of mercury lamps, developing new equipment to meet field application needs. He also became quite an authority on church lighting.

In 1938, Mr. Cooper joined the Public Buildings Administration, of the Federal Works Agency, to handle the design, layout and specifications for all special lighting in all Federal buildings. The large-scale, world-wide project brought forth many new lighting techniques and equipments. During World War II, Mr. Cooper held administrative positions with the War Production Board, in the Lighting and Fixtures Section, serving the industry and government in various capacities.

His latest, and current, activity in the interests of good lighting is in the field of editorial work. At first as Eastern Editor then as Associate Editor of *EC and M*, his primary efforts have been devoted to the writing of articles on lighting in all its phases—including engineering, research, application, selling, distribution, installation, maintenance, market analyses and industry-wide promotion.

Mr. Cooper's IES activities have been equally varied. He has served on many Society committees, both technical and non-technical — Institutions, National Technical Conference, Lighting Service and Golden Anniversary, to name but a few of the more recent. He has been an officer of both the Capital and the New York Section and is a member of the New York Residence Lighting Forum.

During the last twelve years, Mr. Cooper has averaged three or four talks a year before lighting groups, including IES Sections and Chapters, lighting equipment manufacturers, electrical contractors and engineers.

Robert T. Dorsey, Supervisor, Commercial Lighting Application, General Electric Co., Cleveland, Ohio; Cleveland Section.

Patents, IES Conference papers and other articles, design developments and committee activity are all part of Mr. Dorsey's achievements and services in the lighting field. Internationally, he

(*Continued on page* 7A)

Here and There With IES Members

IES National Officers "taking five" from 14-hour executive session held July 23 at Pt. Pleasant, N. J. Seated, l. to r., are: R. G. Slauer, Vice-President; J. B. Browder, President-Elect; J. R. Chambers, General Secretary; G. Frank Dean, Treasurer. Standing: W. P. Lowell, Jr., Finance Committee and G. J. Taylor, IES President.

University of New Mexico architectural student W. Miles Brittelle, left, accepts check and congratulations for his winning entry in the New Mexico Section's Allied Arts contest. Making the presentation is Carl R. Albach of the Section's Allied Arts Committee, while Robert C. Ponto (second from left), third prize winner and R. Douglas Kelley, second prize winner, look on. Project was the lighting design for a modern theatre.

Blackwell Visibility Meter (center in photo at left) surrounded by members of the IES Roadway Committee during their recent inspection tour of the Institute for Research in Vision at Ohio State University. Trip to the Institute was one of the highlights of the Committee's meeting, seen in session at the Pick Fort Hayes Hotel, Columbus, Ohio, in photo at right. Left to right at the meeting are D. A. Toenjes, General Electric; W. E. Schwannhauser, General Electric; W. H. Edman, Holophane and Chairman D. W. Rowten, Westinghouse.

New Fellows

Richard D. Bradley

George W. Clark

Berlon C. Cooper

Robert T. Dorsey

Lawrence E. Johnson

E. A. Linsday

Stanley McCandless

Priscilla Presbrey

(*Continued from page* 5A)

is the representative for the United States on the CIE Committee on Sports and Outdoor Lighting.

Mr. Dorsey's particular forte is in the lighting of stores and affiliated areas, and before assuming his present position he was Store Lighting Specialist for his company. Many of his developments in design and techniques have, naturally, been in this area. He was the main contributor to the store lighting section of the Golden Anniversary issue of IE. He is currently Chairman of the Subcommittee on Revision of the Store Lighting Guide as well as a member of the main Store Committee.

Mr. Dorsey is also a member of the Sports Lighting Committee and was in the group which organized the joint Task Committee on Signs, with the Outdoor Advertising Association of America and the National Electric Sign Association. He has been a member or Chairman of numerous other IES technical committees.

He has presented several papers and discussions of other papers at IES National Technical Conferences. He has contributed to several sections of the *IES Lighting Handbook*, in its various editions. As a speaker, he is in great demand for presentations before IES Regional and Section/Chapter meetings.

Lawrence E. Johnson, Supervisor, Commercial Sales, Minneapolis Division, Northern States Power Co., Minneapolis, Minn.; Twin City Section.

Perhaps the most outstanding of Mr. Johnson's efforts in the service of illuminating engineering have been those devoted to "dissemination of knowledge . . ." Almost every aspect of his activities has been toward this end—whether by example, in the many noteworthy lighting installations he has designed, or by the direct establishment and conducting of lighting courses and the innumerable talks on light, its application and influence on architecture to schools, colleges, art schools, trade schools, study seminars, civic groups and IES meetings.

In 1957, Mr. Johnson was chairman of the committee which set up the section on illumination in the "Guide for Educational Planning of Public School Buildings in Minnesota," published by the State Department of Education. His committee's recommendations were adopted in their entirety and are in practice today. He developed and coordinated the AIA-IES Lighting Seminar for architects and engineers at the University of Minnesota. He developed the Twin City Section's IES Prize Problem in Illumination at the same university.

A charter member of the Twin City Section, he has held every elective position as officer of the Section.

Elston A. Linsday, Supervisor, Industrial Lighting, Application Engineering, General Electric Co., Cleveland, Ohio; Cleveland Section.

Through many media, Mr. Linsday has consistently expounded his concepts on quality and quantity of lighting in industry. These include: IES Technical Conference papers, articles in trade publications, frequent appearances as speaker at IES Regional and Section/Chapter technical programs and membership, over a period of years, on many of the subcommittees working on Recommended Practices in industry, as well as the main Industrial Committee itself.

Mr. Linsday was Vice-Chairman of the ASA Sectional Committee A11, which produced the American Standard Practice of Industrial Lighting, and served

(*Continued on page* 10A)

new cool Sola ballast

easily passes "in-fixture" heat tests

coolest coils and capacitor give full ballast life

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CAT. NO.670-109. HIGH P.
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Ballast for two 40-watt rapid-start lamps
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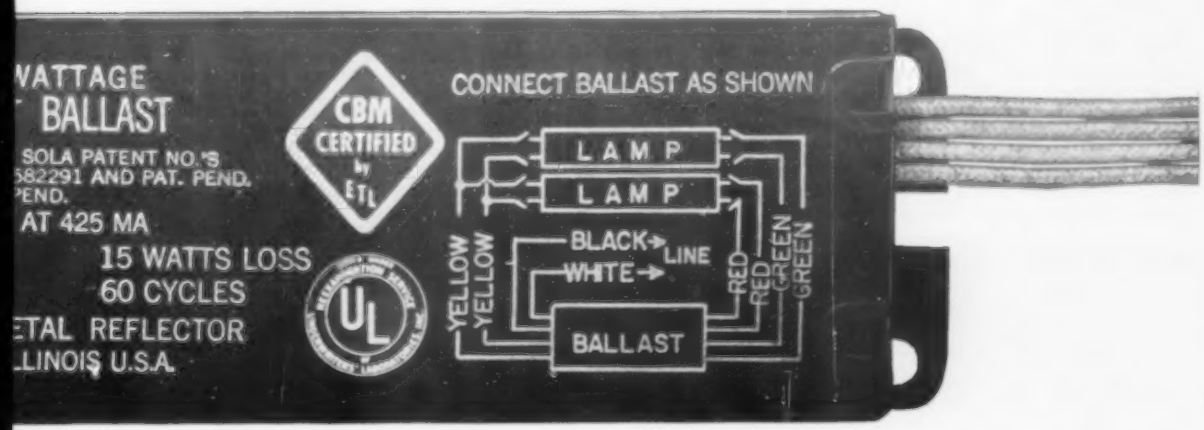
Now—totally new electrical and mechanical design sets highest standards of "in-fixture" ballast performance. This new two-lamp, 40-watt, rapid-start ballast is dramatic evidence of progress made possible by Sola's philosophy of conservative design. Sola views the ballast as integral with the lighting fixture and has consequently built its new ballast to pass exacting "in-fixture" tests and for actual operation under the most demanding conditions.

This new rapid-start ballast is designed to give only a 42°C coil-temperature rise when tested according to U.L. and E.T.L. methods. New circuitry increases ballast efficiency through reduced wattage loss.

The new ballast was tested in a four-lamp fixture, completely enclosed and surface-mounted on acoustical material. Temperature in the fixture channel was 18°C hotter than the usual 40°C ambient of U.L. and E.T.L. tests. Despite these severe test conditions, the following impressive results were recorded.

- *Maximum coil temperature was 89.3°C. This is 15°C cooler than the limit of Class A insulation.*
- *Temperature of the capacitor's case under this especially severe test was within the heat limits of the capacitor's insulation.*
- *The "hot-spot" temperature on the ballast case was 81°C. This is 5°C cooler than premium-priced ballasts similarly tested, and it is 9°C cooler than the maximum allowed under U.L. fixture requirements.*

This new level of cool ballast operation contributes to full ballast life. These improvements result from Sola's concept of ballast engineering that treats the ballast as integral with a fixture and part of the complete lighting system rather than as an isolated component. This approach has produced a major engineering breakthrough — the elimination of thermal insulating barriers which formerly confined ballast heat within the coil and capacitor compartment. Now, heat is far more easily dissipated through the case and fixture. The combination of fixture and Sola ballast now team up for cool, efficient, trouble-free operation.



Send for test ballasts or literature

Sola will furnish fixture manufacturers with samples of this new ballast. Write to us on your business letterhead, and a Sola sales engineer will promptly supply your test ballasts. Sola welcomes the challenge of having you evaluate this cool new ballast in your own fixtures. If you wish merely to examine data on the new model, please request Bulletin 3I-FL-352. Write to the Manager, Lighting Sales.

Sola Electric Co.** (A Division of Basic Products Corp.), **4633 West 16th St., Chicago 50, Ill.

(Continued from page 7A)

as IES representative to the committee for many years. He has also been a member of the IES Progress Committee and is currently its Chairman.

His inventions (either patented or patent pending) in the field of illuminating engineering include optical designs for reflector lamps, both mercury and incandescent filament, and improved socket designs. He is a member of Tau Beta Pi and Sigma Pi Sigma.

Stanley McCandless, Professor of Lighting, School of Drama, Yale University, New Haven, Conn.; and Chief, Design Division, Century Lighting Inc., New York, N. Y.

Mr. McCandless has a world-wide reputation as an authority on the principles and applications of stage lighting, which is, perhaps, equalled only by his stature in the field of lighting of public buildings. Working with some of the most noted architects and designers, he has produced lighting layouts which have won high acclaim. A recent example of such a design was the United States Theatre at the Brussels Worlds Fair (see January 1959 IE, page 9). Innumerable art galleries, auditoriums, churches and the United States Embassy in London have also benefited by his lighting applications. He has done original design of architectural and theatrical lighting equipment and holds patents on downlights, accent lights, etc.

He is the author of two textbooks—*A Syllabus of Stage Lighting*, (1933) now in its tenth edition, and *A Method of Lighting the Stage*, (1933), currently in its fourth edition. A brochure on *Lighting for Architects*, originally published in 1940, was revised for the fourth time last year.

During World War II, Mr. McCandless was Chief in the Blackout and Dimout Section, Civilian Defense Agency.

Priscilla Presbrey, Commercial Engineering Department, Lamp Division, Westinghouse Electric Corp., Bloomfield, N. J.; New York Section.

Miss Presbrey's service to IES and to lighting in general have been many and of a varied nature. Residence lighting, calculations and photometry, nomenclature and standardization have all been, and are, fields for her activities.

A member of the New York Residence Lighting Forum since its formation in 1937, she has been Chairman, Secretary, and on the Executive Board for many years. Also, in the field of residence lighting, she has contributed to the work of the IES Residence Lighting Committee and several of its subcommittees. She is the author of quite a few papers in this field of lighting.

Miss Presbrey has been a member of the IES Committee on Testing Procedures for Illumination Characteristics since 1953; Chairman of its subcommittee on Revision of the Guide for Life Performance Testing of Fluorescent Lamps since 1954, and a member of the subcommittee on Guide for Electric and Photometric Measurements of Mercury Vapor Lamps.

Equally important have been her services on the Nomenclature Committee, of which she was Chairman from 1954 to 1958. It was during this period that much of the revised standard nomenclature was developed.

Miss Presbrey represents the Society on ASA Committee C42, Definition of Electrical Terms; Y10, Y14 and Y32, which have to do with standardization of symbols and abbreviations; and Z58 on Standardization of Optics.

SPEAKERS featured on the excellent Maritime program included, left, A. D. Hinckley, Managing Director of IES and, right, President G. J. Taylor.

Fifth Annual Maritime Conference

Strictly speaking, the IES Conference held each year in the Maritime region of Canada is not classified as one of the nine annual Regional Conferences. In the stature of its technical contributions, however, this meeting each year makes major lighting news, and in format and size compares favorably with the best in lighting conferences. The Maritime Conference is sponsored by the two IES Chapters in the area, Maritime at St. John, New Brunswick and Bluenose at Halifax, Nova Scotia.

This year's meeting was a two-day affair, June 5 and 6, at the Fort Cumberland Hotel, Amherst, N. S. Attendance was 105, a figure which considerably exceeds the total membership of the two sponsoring Chapters. Three special guests of honor were present: IES President George J. Taylor, Canadian Regional Vice-President J. Carl Wilson and from IES headquarters, A. Dexter Hinckley, Managing Director of the Society.

The Conference was officially opened at a luncheon meeting, June 5, with Conference Chairman A. W. Evans, (of Halifax) officiating. Guest speaker at the luncheon was Dex Hinckley, who spoke on "IES Past, Present and Future," giving the members a much greater appreciation of Headquarters operation.

An especially pertinent technical program followed during the rest of this and the following day. Topics included were:

Lighting for Industry — W. N. Wentworth, Amalgamated Electric Co., Montreal.

Color in Lighting—Joseph Thomas, Canadian General Electric Corp., Montreal.

Panel Discussion on Higher Footcandle Levels. *Moderator*—George Robinson, Curtis Lighting of Canada, Ltd., St. John, N.B. *Panel Experts*—G. J. Marshall, L. R. Fairn, Architects, Halifax, N.S.; Joe Thomas, Canadian General Electric Co., Montreal; J. Carl Wilson, J. A. Wilson Lighting & Display, Ltd., Toronto and R. C. Allison, T. Eaton Co., Ltd., Toronto.

Lighting of Public Buildings—W. H. Wright, Curtis Lighting of Canada, Ltd., Toronto.

The Electrical Contractor Speaks on the Lighting Industry—C. Howard Simpkin, Electrical Contractor, Montreal.

Progress in Light Sources—J. W. Bateman, Canadian General Electric Co., Toronto.

Merchandising with Light—R. C. Allison, T. Eaton Co., Ltd., Toronto.

New Lighting Levels Challenge the Plastics Industry—J. Carl Wilson, J. A. Wilson Lighting & Display, Ltd., Toronto.

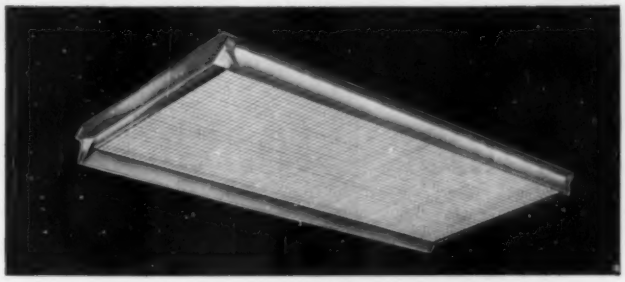
Two additional addresses highlighted the Conference—one an inspiring report

(Continued on page 15A)

For Architecture and Sculpture in lighting specify the –

SCULPTURAMA

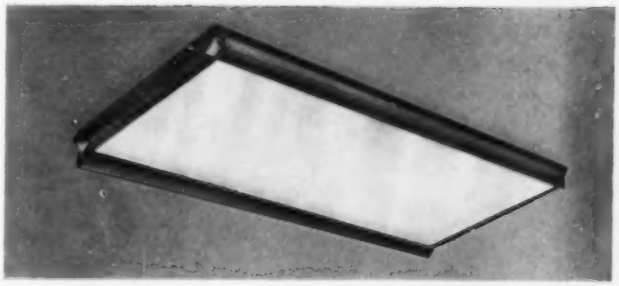
THE SCULPTURED LOOK IN LIGHTING



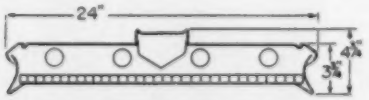
QPLM7500 with miniature-celled plastic louver shielding

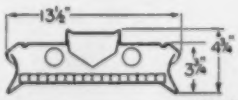
QPCX7500 with SUNLUX; *clear optically sharp plastic lens panel*

QCA7500 with translucent white Albalite glass diffuser



SCULPTURAMA, the Sunbeam Lighting Company's #7500 series Visionaire®, has the refinement in design and the sculptured look which fuses itself with today's architecture. Shallow in appearance, it forms a surface mounted, "area" source of pleasant, low-brightness illumination. All-metal sides are gently curved and are illuminated with interflected light to reduce fixture-to-ceiling contrasts. The sturdily framed single-element diffuser opens from either side on continuous "hook-on" hinges and may be completely removed without use of tools. For maximum versatility, SCULPTURAMA is available in a wide range of diffusing mediums, including SUNLUX, for 2 or 4 rapid start lamps and for single or continuous row installation. Write for bulletin #A84c





patents pending

visionaire

SUNBEAM LIGHTING COMPANY LOS ANGELES, CALIFORNIA • GARY, INDIANA

PERFOR

Number 1 reason why the best bargains

IN FLUORESCENT LAMPS, buying on price alone is no bargain at all. (Because the price of the lamps averages only 10% of the operating costs of light.) The other 90% goes for electricity and maintenance. Conclusion? The *best* lamp bargain works your customers' lighting dollar the hardest, gives the most *light* for their money.

How do G-E Fluorescents stack up? Take the popular 4-foot, 40-watt. The new General Electric PREMIUM 3 Lamp, announced in 1959, delivers more light per watt than any previous 4-foot fluorescents. As for maintenance—out of every 1,000 G-E 40-watt fluorescents you sell today, on the average 999 have no defect which can keep them from working—and 990 will still be burning late in 1961! Practically maintenance-free performance like this makes G-E 40-watt, slimline, high output and the exclusive Power Groove Lamps your customers' best bargains in fluorescent light.

IN MERCURY LAMPS, you have the source which can give customers the lowest cost of light of any type of lamp commercially available. Lower than filament—often lower, even, than fluorescent. *And General Electric Mercury Lamps, at any given time in their life, will outperform any other brand the same age* . . . and are built to last as long or longer!

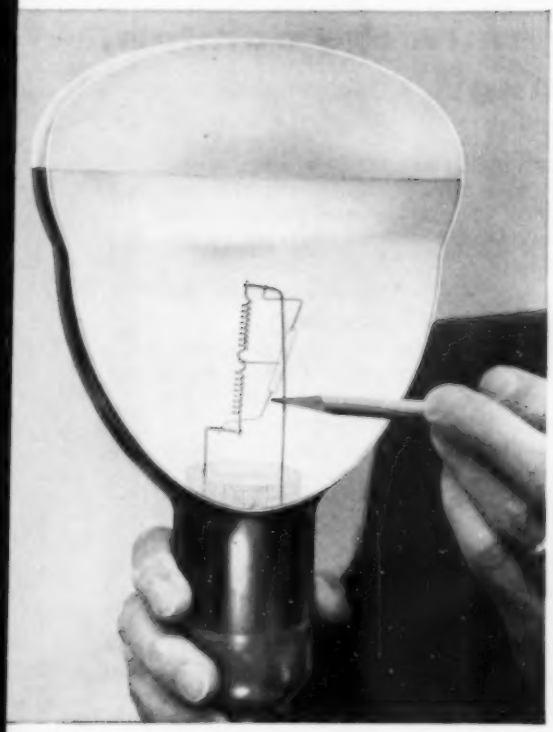
How? In many ways. To name a few—General Electric's dramatic new Bonus Line electrodes, better arc-tube design, and fewer parts to intercept light. And a new 1959 line of six G-E Bonus Line 400-watt Mercury Lamps are the *biggest* bargain in mercury light.

IN FILAMENT LAMPS there are some important differences between brands—some of which are detectable even *before* the lamp goes in a socket. Like the new 1959 smaller, brighter, 100-watt lamp bulb that's small as a 60-watter but delivers more initial light than two 60's. Or the new 1959 G-E Quartzline lamps that are pencil-thin but pack up to 1500 watts.

Or like the new 1959 RB-52 Bonus Line 1000-watt reflector lamp shown at right. Special bulge shape distributes heat, so a less-costly, regular glass is used—with savings passed on to your customers. And look! It uses General Electric's stand-up filament that delivers more light than ordinary "draped" type, has more expensive *silver* reflector instead of aluminum. It gives 20-30% extra light on the work plane. Big things are happening in G-E Filament lamps—all pointing to a bigger bargain in filament light for your G-E Lamp customers.

MANCE

in light are General Electric Lamps



IF YOU RECOMMEND REPLACEMENT LAMPS, then lamp selection is relatively easy. For new installations, however, the job is not often that simple. For this reason General Electric's corps of engineers, technicians and specialists are as near as your phone—to help you help your customers pick the right General Electric Lamp that'll give them the best bargain in light. They'll even aid in recommending the lamp type, size and "color" best for each customer's individual lighting conditions.

FREE FROM G. E. Right now... today you can get a startling new 20-page picture paper packed with factual information on lamps and lighting that can help your customers save big money. For your free copy just send your name and address to General Electric Co., Large Lamp Dept. C-931, Nela Park, Cleveland 12, Ohio. Be sure to ask for "FACTS OF LIGHT". See your G-E Large Lamp Representative for larger quantities.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Photo courtesy Wheeling Steel Corporation, Wheeling, West Virginia (Benwood Works)

Wheeling Steel specifies...

Abolite uplight fixtures for extra eye comfort, economical high bay lighting

These Abolite uplight fixtures are mounted forty feet high, yet there's comfortable, glareless 32 footcandle average light throughout this high bay building. Light directed upward through the fixture's open top eliminates sharp contrasts by washing out dark background shadows. Glare is virtually eliminated by 35° lamp shielding.

Abolite's modern air-swept design also reduces maintenance costs. Air circulating through the fixture sweeps it clean of dulling dust.

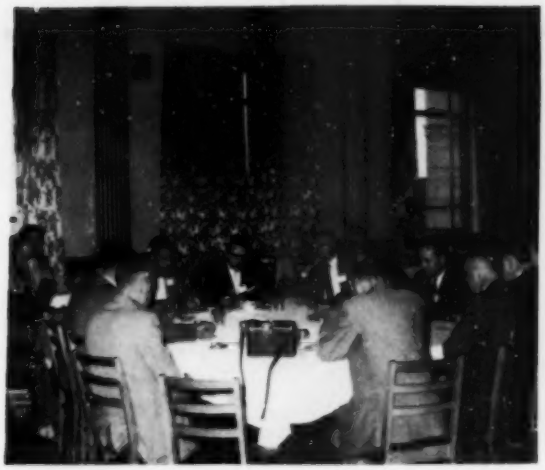
You can choose from several Abolite uplight units for high bay lighting: 18" and 24" diameter Alzak aluminum fixtures for use with 400 and 1000 watt mercury lamps and 14" and 18" diameter Alzak aluminum fixtures for 300-500 watt incandescent lamps (ideal for gymnasium lighting). For full information see Sweet's Industrial Construction File 12i/AB, or write *Abolite Lighting Division, The Jones Metal Products Company, West Lafayette, Ohio.*

INSTALLATION DATA:
Abolite Cat. No. HMFAU-2400 Alzak aluminum uplight fixtures with 400 watt white reflector mercury lamps. Mounting height 40' with 16' x 20' spacing. Average footcandle level: 32.

ABOLITE Lighting

THE JONES METAL PRODUCTS COMPANY
West Lafayette, Ohio

eye-fi RE/LIGHTING



MARITIME area chairmen, incoming and retiring, met for an early morning breakfast and Local Activities session on the second day of the Conference. Chairman for the meeting was Canadian Regional Vice-President J. Carl Wilson; also present, for suggestions and guidance from Headquarters, was Managing Director A. D. Hinckley.

PANEL on "Higher Footcandle Levels," the lighting industry's most current topic, was manned by, l. to r.: Joe Thomas, Canadian General Electric Co.; J. Carl Wilson, J. A. Wilson Lighting & Display Co.; Moderator George Robinson, Curtis Lighting of Canada; R. C. Allison, T. Eaton Co. and Geoffrey Marshall, architect.

(*Continued from page* 10A)

on the technical activities of IES by President Taylor at the Saturday evening banquet; the other a talk by Dan Wallace, Director of the Nova Scotia Department of Travel and Information at the "gentlemen's luncheon."

Social activities for the Maritime Conference began with a golf tournament on Friday morning; the newly-established golf trophy being won by the Bluenose Chapter. Prize for the lowest score by a Conference visitor (a model of the world-famous sailing racer *Bluenose*), was won by Canadian RVP Carl Wilson.

On Friday evening, three busloads of delegates departed for a beach at Pugwash where they made short work of more than 150 pounds of freshly-cooked lobsters. Saturday night closing activities included a reception sponsored by the Maritime Chapter and a banquet and ball honoring President and Mrs. Taylor. In appreciation of their visit, Bluenose Chapter Chairman Don C. Myra presented the guests of honor and Dex Hinckley with souvenir gifts on behalf of the delegates.

Personnel responsible for this successful IES meeting were:

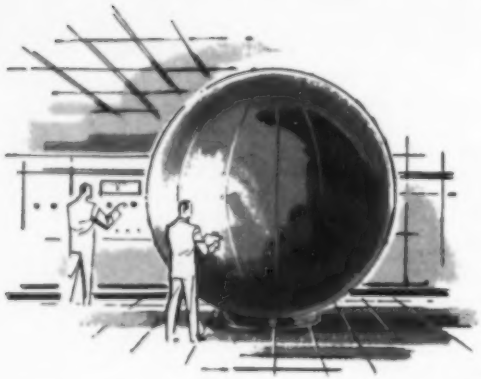
Conference Chairman	A. W. Evans
Speakers and Program	G. A. MacDonald, J. R. Levine
Finance	John Manning
Hotel and Registration	Reg Rice
Publicity	K. L. Graham
Entertainment	Ferris Abbass, Jack Ferraris
Chairman, Bluenose Chapter	D. C. Myra
Chairman, Maritime Chapter	W. F. McElman

(*Lighting News continued on page* 18A)

NOVA SCOTIA lobster picnic at the shore was one of the most popular features of the Maritime Conference's social program. At left, the tartan-clad group lines up for lobster hot out of the kettle. At right, IES Director Joe Thomas, Canadian Regional Veep Carl Wilson and Managing Director Dex Hinckley enjoying their share.

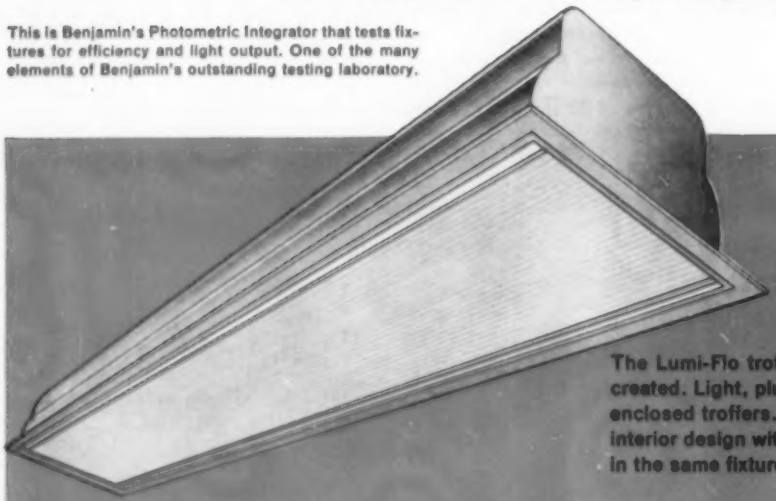
Men who are light years ahead specify...

BEN



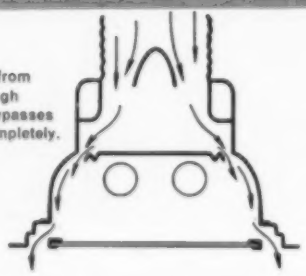
This is Benjamin's Photometric Integrator that tests fixtures for efficiency and light output. One of the many elements of Benjamin's outstanding testing laboratory.

Look first to Benjamin for commercial or industrial equipment that can be depended upon to interpret your conception, functionally and aesthetically. A Benjamin lighting unit is available for any type of architecture and can be used daringly to create special dramatic effects—or conventionally for proven practical results.

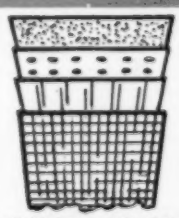


LUMI-FLO

The Lumi-Flo troffer. Truly the most versatile fixture ever created. Light, plus cool or warm air pass through glass enclosed troffers. Makes possible cleaner, more attractive interior design with air diffusion and illumination combined in the same fixture.



Air flows from duct through fixture—bypasses lamps completely.



Available in a variety of styles with glass or plastic lenses and aluminum or plastic louvers.

Enhances ceiling beauty—no more clutter of unsightly air diffusers.

jAMIN

Call on us early in the planning stages. Our field engineers are at your service with helpful ideas in planning creative lighting for any commercial or industrial application.

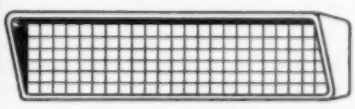
Literature is yours for the asking. Write to Benjamin Electric Manufacturing Company, Northwest Highway, Des Plaines, Illinois.

BENJAMIN ELECTRIC MANUFACTURING CO.
Des Plaines, Illinois
Subsidiary of
THOMAS INDUSTRIES INC.
BENJAMIN • MOE LIGHT • STAR LIGHT
ENCHANTE • SAN MARINO

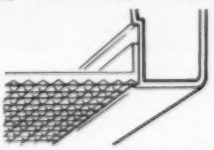
CATALINA

The Catalina. Today's most popular commercial lighting fixture. Adaptable to almost any commercial lighting application. A simplified quality lighting unit that offers ease of wiring layout and universal adaptability. Dynamic, uninterrupted light over entire fixture—no shadows—no braces—no dark spots.

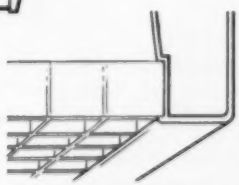
Harmonizing slim design—just 3½ inches from top to bottom.



Modern design decorative end caps of tough injection-molded plastic.



All new exclusive L-120 polystyrene lens. Unique debossed pyramid design.



45° x 45° louver in sparkling polystyrene. Has special half-inch cube.

WELCOME and a key to the city of Buffalo is presented to IES President G. J. Taylor by the city's Commissioner of Public Works, Francis J. Downing. Presentation was made at the opening session of the conference.

SYMBOL of IES, "Ever Burning Lamp of Learning," a gold trophy is presented to President Taylor by Robert Herget, right, Western New York Section Chairman. Conference Chairman Byron F. Lyth, Jr., looks on.

Great Lakes Winds Up 1959 Regional Conferences

"Last but not least" the phrase goes, and definitely "not least" was the Great Lakes Regional Conference, the final one in the IES 1959 schedule. The Region has always had the reputation for well-organized smoothly-operated meetings and the June 22-23 conference at the Hotel Lafayette, Buffalo, N. Y., lived up to it. Western New York Section was host to the gathering.

Things got underway on Sunday evening, June 21, with a Regional Activities Committee meeting, Robert W. Brown, Vice-President, presiding. Members from the nine Sections attended. Officially, the conference was opened Monday morning by Chairman Byron F. Lyth, Jr. Delegates were welcomed by Buffalo Commissioner of Public Works Francis Downing, representing the Mayor, who presented a key to the city to IES President George Taylor. President Taylor then gave his address on the status of lighting today.

There were eleven entries in the MMILJ contest which followed. Winners, which were announced at the banquet that evening, were:

Class I—Residential

First—F. Brendon Burke, Ferguson Electric Construction Co., Buffalo, N. Y.; Western New York Section. "Lighting a Residence for a Large Family."

Second—Mrs. Marion Amsbary, Detroit Edison Co., Detroit, Mich.; Michigan Section. "A Basement Gets a Face Lifting."

Third—Scott Nagel, Nagel Electric Co., Toledo, Ohio.; Northwestern Ohio Section. "Blending Modern Lighting Into a Colonial Atmosphere."

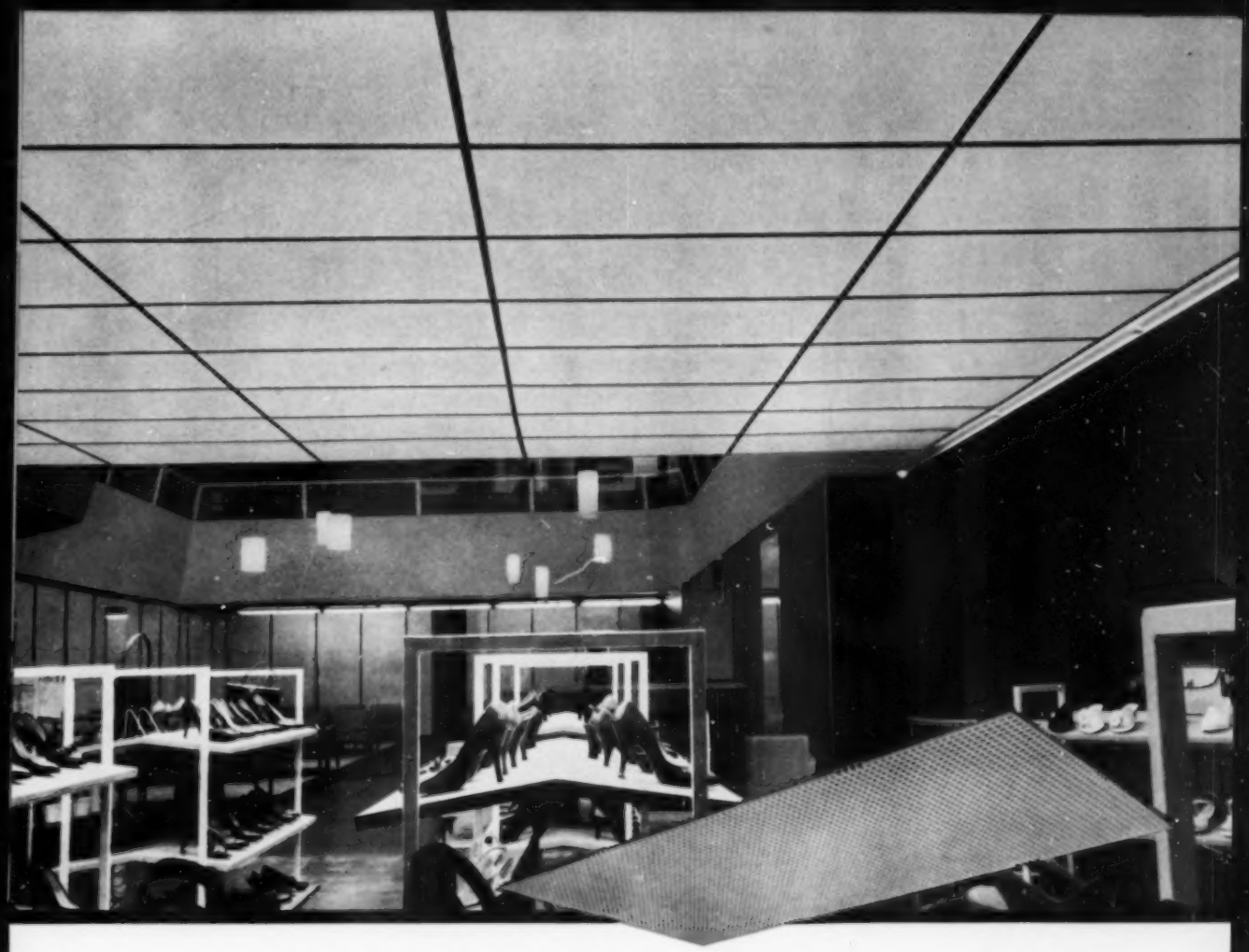
Class II—Commercial-Industrial

First—Herman S. Williams, Schatz & Associates, Cincinnati, Ohio; Ohio Valley Section. "Relighting Cincinnati Music Hall Ballroom." Award received by Fred B. MeRae, proxy.

Second—T. E. Barhite, Jr., New York State Electric & Gas Corp., Lockport, N. Y.; Western New York Section. "Allie Brandt Bowling Lanes."

(Continued on page 23A)

CONTESTANTS in MMILJ Contest are, l. to r.: Front row, J. W. Felkey, Northwestern Ohio; Tunis Barhite, Jr., Western New York; Mrs. Marion Amsbary, Michigan; H. S. Glick, Rochester; F. Brendon Burke, Western New York; back row, Donald Esterbrook, Central New York; Scott Nagel, Northwestern Ohio; Fred B. MacRae, Ohio Valley; L. O. Banahan, Contest Chairman; C. F. Kramsvogel, Western Michigan; George Blain, Cleveland; Lawrence Beck, Michigan.



Sinko low brightness louvers

in practical pastel Colors

Sinko THIN-CELL Louvers' enchanting pastel colors complement any interior. Sinko Louvers not only reduce surface brightness and increase working level efficiency, they also add a warmth and charm to any room through their soft pastel colors.

Quality control, greater flexibility, immediate delivery are yours when you specify Sinko THIN-CELL Louvers, because Sinko is the only manufacturer who produces and sells their own Louvers —no other louver can offer you these advantages.

The design and construction of Sinko Louvers has met the requirements of architects, interior decorators and builders in many prominent installations.

Sinko THIN-CELL construction has many advantages: Molded plastic that has permanent color-fast beauty, with high impact strength and rigidity, making Sinko Louvers easy to handle and durable, regardless of size; apertures of ½" x ½" x ½" with a true 45° x 45° cutoff for greater light transmission with no sacrifice of mechanical strength.

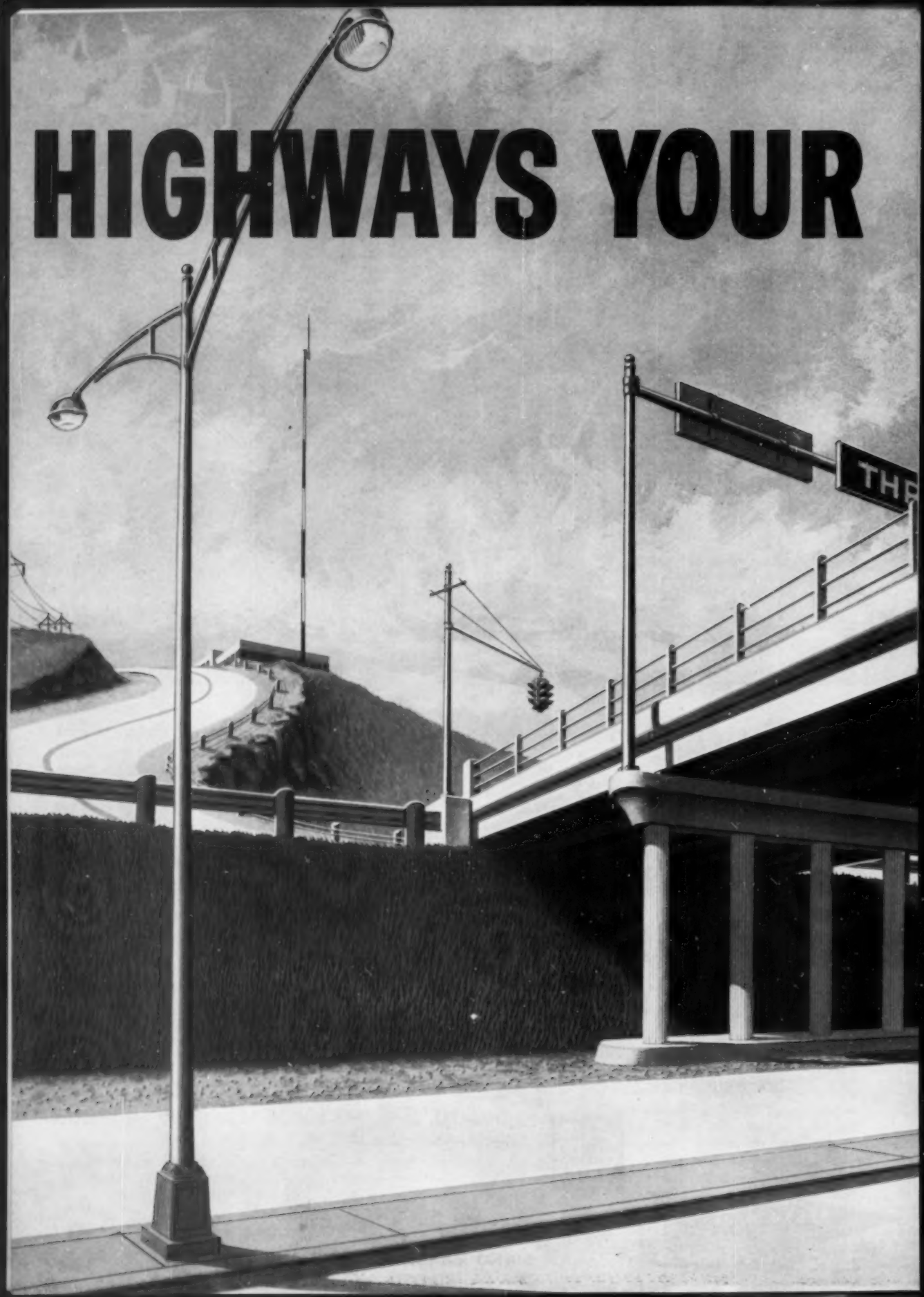
THIN-CELL Louvers are available in white and five beautiful pastel colors—blue, pink, aqua, yellow and gray.

SEE OUR CATALOG IN SWEET'S

SINKO THIN-CELL louvers

produced and sold by

SINKO MANUFACTURING AND TOOL CO.
7310 W. WILSON AVE., CHICAGO 31, ILL.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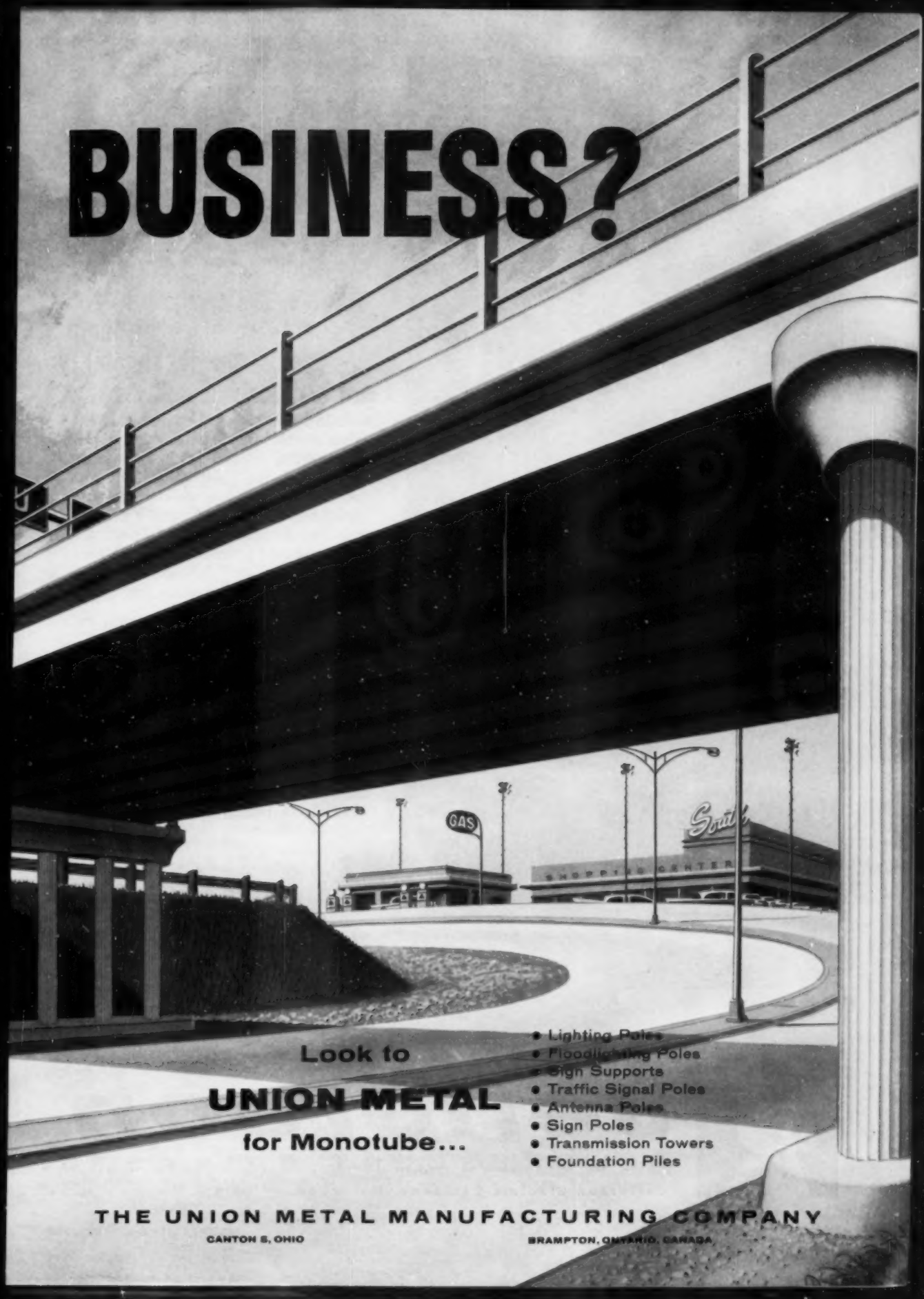
BUSINESS?
GAS
Look to
UNION METAL
for Monotube...
• Lighting Poles
• Floodlighting Poles
• Sign Supports
• Traffic Signal Poles
• Antenna Poles
• Sign Poles
• Transmission Towers
• Foundation Piles
THE UNION METAL MANUFACTURING COMPANY
CANTON 5, OHIO
BRAMPTON, ONTARIO, CANADA

A VERY PRIVATE EYE

The industry's most intensive quality control system gets the evidence on every piece of raw material and part... to guarantee the light, lamp life and ballast dependability you pay for!

Case in point: the vital basic steel itself. While almost all ballast manufacturers test the electrical characteristics of silicon "core" steel, JEFFERSON actually cuts the steel into core-size and core-shape laminations. These are carefully weighed and then electrically tested to determine exact core loss, permeability, and other critical factors. *Only Jefferson* uses this exacting method of checking core steel.

The results pay-off for you—because each JEFFERSON ballast you buy controls the lamp within exact operating requirements. This is one basic reason you can feel assured JEFFERSON ballasts prolong rather than diminish the life of your lamps—by providing proper filament voltage—which guards against shock-starting. And, naturally, your maintenance costs are cut even more because the ballasts themselves last much longer!

All "purchased parts", such as condensers, are processed through a statistically controlled receiving inspection department. Here condensers are being precision tested for capacitance to assure proper power factor correction of the finished ballast.

This is only part of the Jefferson quality control story. *Ask your Jefferson man to show you how the industry's only 100% system protects your ballast and lamp investment every step of the way.*

Jefferson

FLUORESCENT BALLASTS

Jefferson Electric Company Bellwood, Illinois

WHAT'S going on where? Everyone could tell from signs such as this one. Admiring the work of William F. Guminski, left, lighting and display chairman, are Robert W. Brown and Byron F. Lyth, Jr.

(*Continued from page* 18A)

Third—George Blain, Stickel Associates, Cleveland, Ohio; Cleveland Section. "The Relighting of Kulas Memorial Auditorium."

Award of Merit—Lawrence H. Beck, L. H. Beck Electric Co., Detroit, Mich.; Michigan Section. "A New Concept in Office Lighting."

Chairman of the MMILJ contest was L. O. Banahan, Chairman of the Cleveland Section.

Also at the President's Banquet, Mr. Taylor was presented with two gifts, a transistor radio and gold trophy replica (see pic) of the symbol of IES, "The Ever-Burning Lamp of Learning," inscribed "Illuminating Engineering Society—Western New York Section."

While members attended technical sessions, their wives were kept busy with the program planned for them. This included breakfast at the Sheraton Hotel, during a radio show, following which they boarded a bus for a tour of the spectacular Niagara Falls. Luncheon was at the Sheraton-Brock which overlooks the majestic gorge and falls. They later attended the reception and banquet. Tuesday morning was free for shopping and in the afternoon they had an opportunity to view the production of the live television show, "For the Ladies," at the studios of WKBW-TV.

TECHNICAL PROGRAM

June 22—Morning

Call to order and introduction of officers—B. F. Lyth, Jr., Conference Chairman.
Welcome to Buffalo—Francis Downing, Commissioner of Public Works.
Opening Remarks—R. W. Brown, Regional Vice-President.
Keynote Address—George J. Taylor, President.
My Most Interesting Lighting Job Contest—Chairman, L. O. Banahan, Cleveland Section.

June 22—Afternoon

W. Winglar, Chairman, Western Michigan Section, Presiding.
J. F. McKeand, Chairman, Miami Valley Section, Discussion Organizer.
Combination Light and Air Distributing Troffer Systems—E. H. Witte, Benjamin Electric Mfg. Co.
The Latest in Light Sources—E. A. Linsday, General Electric Co.
Ballast Design and Application—A. S. Levine, Sola Electric Co.

June 23—Morning

J. S. Haney, Chairman, Central New York Section, Presiding.
F. B. MacRae, Chairman, Ohio Valley Section, Discussion Organizer
Airport Lighting—Past, Present and Future—H. M. Pattat, Crouse-Hinds Co.
Intelligent Use of Today's Industrial Lighting Tools—T. Ake, The Miller Co.
Trends in Shielding Media—G. W. Clark, Sylvania Lighting Products.
Progress Report (Luncheon Address), Reaching for the Sun—E. A. Linsday, Chairman, IES Progress Committee.

June 23—Afternoon

L. W. Crotser, Michigan Section, Presiding.
R. J. Gross, Chairman, Northwestern Ohio Section, Discussion Organizer.
Recent Developments in Street Lighting—Dana Rowten, Westinghouse Electric Corp.
New Home Lighting Products and Application Ideas—Miss Eve Freyer, Westinghouse Electric Corp.

CREDITS

Credits for a well-planned and executed conference are due:

Byron F. Lyth, Jr., Chairman
Edward J. Cunningham, Vice-Chairman
Lee R. Menteer, Secretary
Silvio P. Filipetti, Treasurer
N. H. Harrington, Attendance and Publicity
Joseph N. Kellas, Entertainment
Lee R. Menteer, Hotel
Marjorie Kellas, Ladies
W. F. Guminski, Lighting and Decoration
Willard E. Hayes, Papers and Program
Donald F. Kramer, Transportation
Harry E. Sandusky, Registration.

(*Lighting News continued on page* 24A)

AT THE HEAD TABLE during the President's Banquet are, l. to r.: IE Advertising and Promotion Manager C. E. Ellis and Mrs. Ellis; National President G. J. Taylor and Mrs. Taylor; Conference Chairman Byron F. Lyth, Jr., and Mrs. Lyth; Regional V-P R. W. Brown and Mrs. Brown; and Managing Director of IES A. D. Hinckley.

ANIMATED round-table discussion on the industry's most talked-about topic—new footcandle levels—at a meeting of the New Mexico Section. A. W. Boehning, Jr., at right at head of table, presided over the session.

Plastics Engineers Plan First National Conference

The first National Technical Conference of the Society of Plastics Engineers, Inc., will be held October 13-14, 1959 at the Ambassador Hotel, Los Angeles, Calif. The Conference is being sponsored by the Southern California Section of the Society and will feature 25 technical papers, following the general theme "Plastics Engineering—The State of the Art Today." Sessions scheduled include new materials, new techniques in processing of thermoplastic and thermosetting materials, quality control and end uses of plastics. A general open forum discussion with all speakers on hand for questions is planned for the afternoon of October 14.

In connection with the SPE Conference, the Los Angeles Chamber of Commerce is sponsoring a Plastics Industry Banquet in recognition of the industry's contributions to the economy of Southern California, and Mayor Poulson of Los Angeles has proclaimed the week of October 11-15 as Plastics Industry Week.

Fifth Electrical Industries Show To Be Held March 6-9

The Fifth National Electrical Industries Show, sponsored by the Eastern Electrical Wholesalers Association, will be held March 6-9, 1960, at the New York City Coliseum. Over 300 booths representing all phases of the electrical industry will be included, demonstrating the latest in electrical construction materials and apparatus, wiring devices, electrical heating and others. A prominent feature of the exhibits will be a heavy concentration on the electrical tool field.

American Electrical Industries Expositions, Inc., Harold R. Meyer, Director, is producing this show, which will be open only to the trade.

Symposium on Visual Research Sponsored by IERI

A most successful conference on visual research designed to provide a basis for illuminating engineering was held on June 10-11 in Ghent, Belgium, under the sponsorship of the Illuminating Engineering Research Institute. The purpose of the meeting was to provide a medium of exchange, in an informal atmosphere, among researchers from Europe and the United States.

Discussions at the meeting concerned visual performance, quantity and quality of illumination, direct and reflected glare, oculomotor functions and visual fatigue. Participants were:

From Belgium—G. Verriest, Ophthalmological Clinic, University of Ghent, Ghent.
From England—F. W. Campbell, Physiological Laboratory, Cambridge; J. Collins, R. G. Hopkinson, P. Petherbridge, all of Department of Scientific and Industrial Research, Garston; B. Shackel, Psychological Research Laboratory, Feltham, H. C. Weston, Institute of Ophthalmology, London.
From France—E. Baumgardt, Laboratoire de Physiologie Generale, Paris; Jean Dourgnon, Centre Scientifique et Technique, Paris; Y. LeGrand, Laboratoire de Physique, Paris.
From Germany—Mr. Muck, Deutsche Phillips G.m.b.H., Hamburg.
From Holland—J. J. Balder, J. B. deBoer, A. B. deGraaff, L. Kalff, Mr. Spaa, all of Philips Gloeilampenfabrieken, Eindhoven; M. A. Bouman, Instituut Voor Zintuigfysiologie RVO-TNO, Kampweg.
From Switzerland—E. Grandjean, Institut fur Hygiene and Arbeitsphysiologie der Eidgenossischen, Zurich.
From the United States—H. R. Blackwell, Institute for Research in Vision, Ohio State University, Columbus, Ohio; R. M. Boynton, Department of Psychology and Optics, University of Rochester, Rochester, N. Y.; C. L. Crouch, Illuminating Engineering Research Institute, New York, N. Y.; D. M. Finch, Illumination Laboratory, University of California, Berkeley, Calif.; G. A. Fry, School of Optometry, Ohio State University, Columbus, Ohio; S. K. Guth, General Electric Co., Cleveland, Ohio; P. F. O'Brien, Department of Engineering, University of California, Los Angeles, Calif.; E. M. Strong, Cornell University, Ithaca, N. Y.

While an informal atmosphere was stressed at the Symposium, each researcher was asked to give a short summary of his work, after which the meetings were opened to discussion. There were four half-day sessions, each devoted to a different topic:

Wednesday, June 10

Visual Performance and Quantity of Illumination: Chairman — R. G. Hopkinson; *Speakers*—G. A. Fry, H. C. Weston, H. R. Blackwell, J. J. Balder.
Direct Discomfort Glare: Chairman—E. M. Strong; *Speakers*—S. K. Guth, R. G. Hopkinson, Muck, L. Kalff.

Thursday, June 11

Reflected Glare and Visual Performance: Chairman—G. A. Fry; *Speakers*—D. M. Finch, R. M. Boynton, J. Collins, E. Grandjean.
Oculomotor Functions and Quantity of Illumination: Chairman—Y. LeGrand; *Speakers*—E. Baumgardt, B. Shackel, F. W. Campbell, R. G. Hopkinson.

European and American researchers were enthusiastic about the results of this Symposium (they still talked about it at the meetings of the CIE in Brussels) and it is hoped that further meetings of this kind will be held in the future.

Nominations for Gold Medal Due by January 1

According to official IES procedures, nominations for the Society's Gold Medal Award for 1960 must be received, by the General Secretary, at Headquarters, by January 1.

The Gold Medal, IES's highest honor, is awarded "for the purpose of giving recognition to meritorious achievement which has conspicuously furthered the profession, art or knowledge of illuminating engineering." It is accompanied by an embossed parchment certificate of award.

Nominees for the Medal need not be members of the Society or citizens of the United States or Canada. Nominations may be made by any member, at any time by presentation of the name of the indi-

(Continued on page 29A)

problem

High-foot-candle levels from recessed fixtures were required for Pereira & Luckman's contemporary design of the new IBM Western Headquarters Building.

solution

The ARGUS LUMINAIRE was designed by Lighting Dynamics. Now in production, it is the first recessed troffer using high output and very high output lamps supplying high-footcandle levels to critical seeing areas in drafting, engineering rooms, laboratories, banks, and offices. ARGUS' clean contemporary lines produce EXCITING ARCHITECTURAL EFFECTS with long parallel strips of unbroken light. This new series comes in a WIDE VARIETY OF WIDTHS AND LENGTHS that completely integrate with ceiling materials. Easy to install. As with all Lighting Dynamic luminaires, the Argus features durable, Bonderized and electrostatic, high-reflectance finishes. FOR MORE COMPLETE INFORMATION fill out the coupon below and mail to Lighting Dynamics, 802 West Whittier Boulevard, Whittier, California; or to Lighting Dynamics, 8700 Ambassador Row, Dallas, Texas.

_____*Send more information on* ARGUS.

_____*Send your new catalog.*

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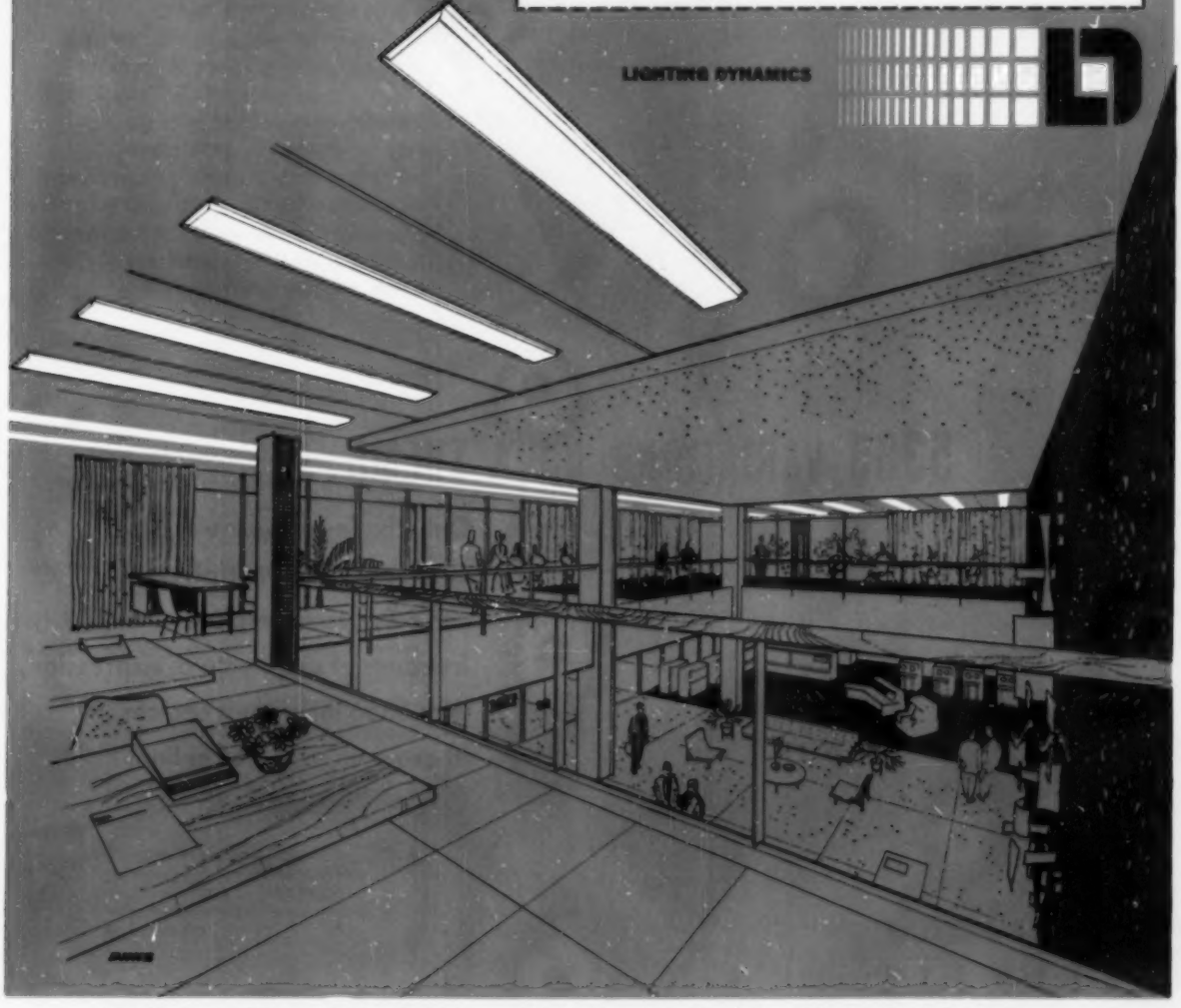
ADDRESS _____ TITLE _____

LIGHTING DYNAMICS



ARGUS as it will be used in the IBM Western Headquarters Building designed by Pereira & Luckman.

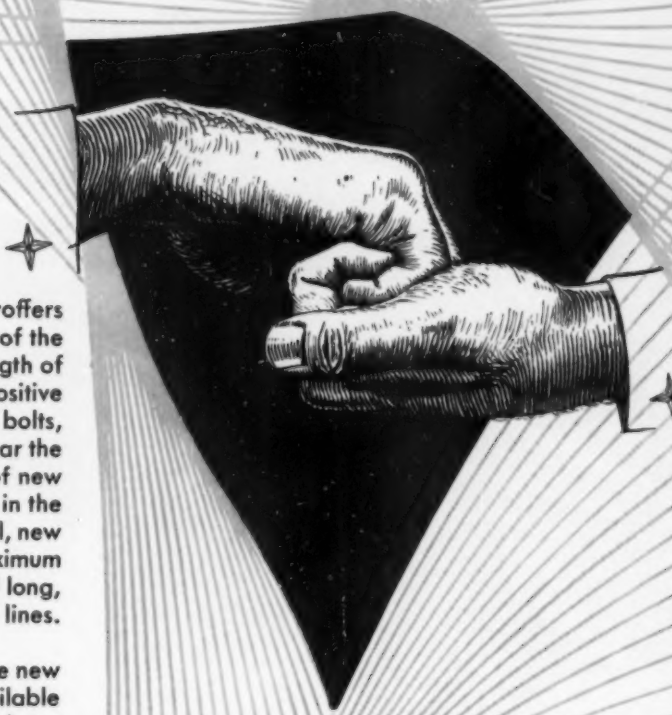
from *Smithcraft* imagination in lighting

5366 VARIATIONS ON A THEME...

Only the incomparable
new Speedomatic troffers
can offer you complete
freedom of architectural expression,
with 5366 individual choices
in one complete troffer line.

simplicity — the key to positive light seal

new Smithcraft SPEEDOMATIC TROFFERS



New Smithcraft Speedomatic troffers utilize the principle of the interlocking grip, the full length of the door frame, assuring positive light seal. There are no visible bolts, catches or hinges to mar the architectural beauty of new Speedomatic troffers. Framed in the ceiling by a single width of metal, new Speedomatic troffers offer maximum illuminated areas and long, free-flowing precise lines.

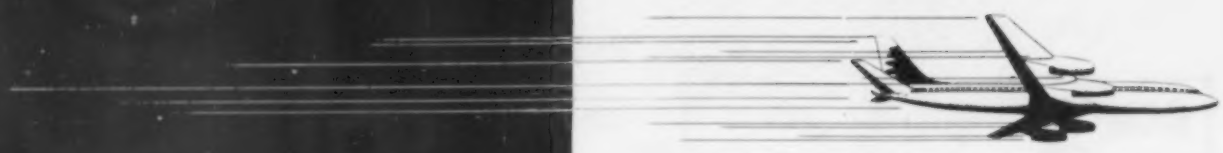
Today's most versatile troffer, the new Smithcraft Speedomatic is available in one- and two-foot wide widths, in an abundance of sizes and shieldings that add up to 5366 individual choices in one complete troffer line. This unique versatility allows the architect complete freedom of expression in lighting arrangements.

Specifying and ordering of Speedomatic is extremely simple — four basic types fit over 100 ceiling systems (as listed in Smithcraft's complete Ceiling Index).

For complete information on versatile, trim Speedomatic troffers, and Smithcraft's Ceiling Index, write for complete 30-page catalog and price list.

+ Light-conditioning by Smithcraft — America's finest fluorescent lighting

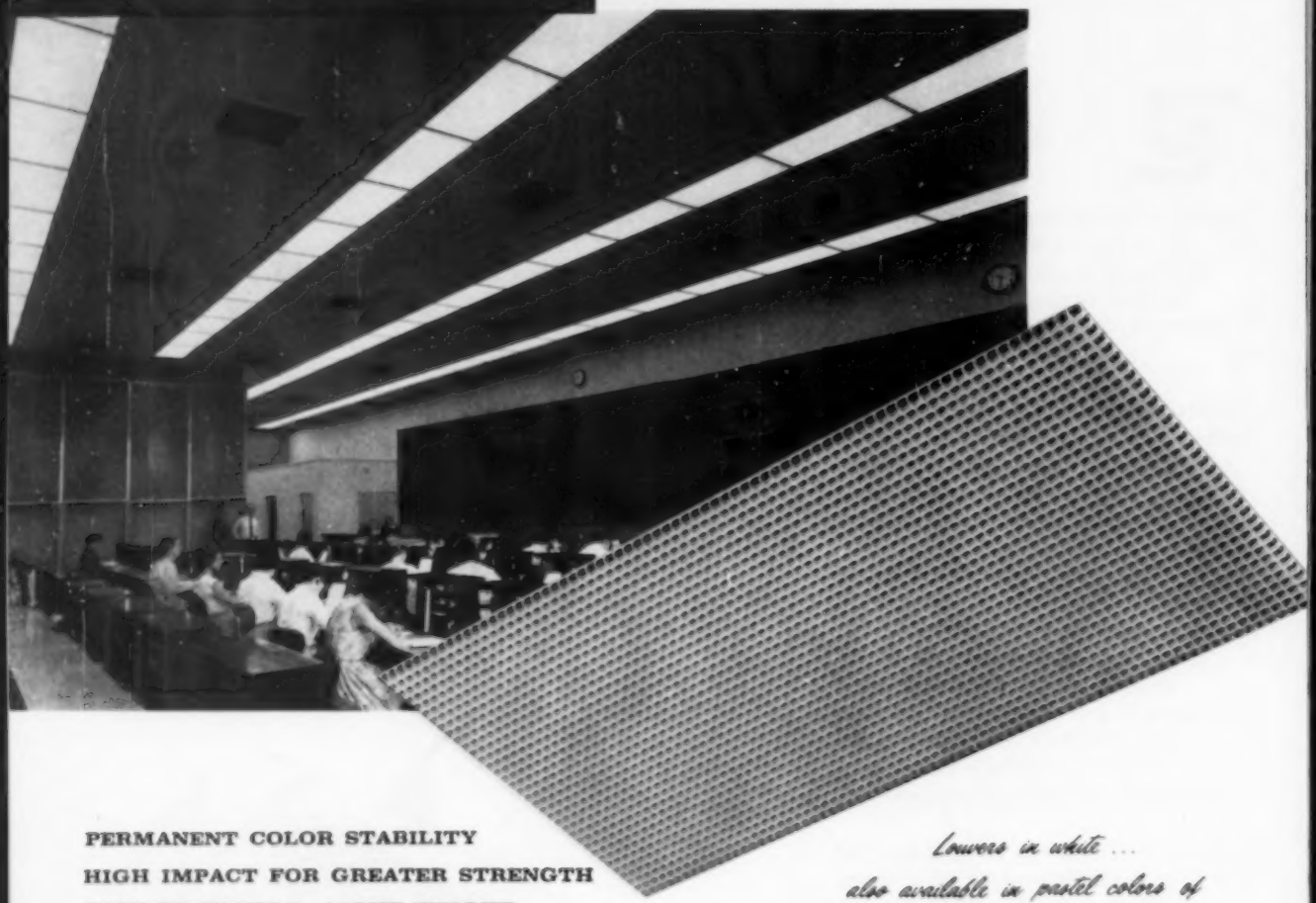
Smithcraft
LIGHTING
CHELSEA 50, MASSACHUSETTS



American louvers exclusive design and construction provide highly efficient lighting levels, without glare —they conform to or above the standard recommendations for proper light shielding—Leading architects and consulting engineers specify and use American plastic louvers due to their versatility and easy adaptability to most lighting installations.

eastern air lines feature american plastic louvers—

for perfect shielding with unexcelled seeing comfort and efficiency required for todays high-speed service.....



PERMANENT COLOR STABILITY

HIGH IMPACT FOR GREATER STRENGTH

EASY TO HANDLE—LIGHT WEIGHT

5/8" CELLS 45° x 45° LIGHT CUTOFF FOR GREATER LIGHT TRANSMISSION

PATENTED INTERLOCKING LOUVERS ASSURE PERFECT ALIGNMENT

LOW COST UPKEEP—EASY TO CLEAN

AVAILABLE IN COMBINATION OF SIZES

LOUVERS MAY BE CUT TO SPECIFICATIONS

Louvers in white ... also available in pastel colors of blue, pink, green, yellow and low brightness

Engineers are available in your area to help with your lighting problems or write American Louver Company direct.

Exclusive process by American Louver Company
U.S.A. Patent No. 2,566,817 U.S.A. Patent No. 2,607,455
Canadian No. 484,346 Canadian No. 497,047

american louver company

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(Continued from page 24A)

vidual whose accomplishments are deemed worthy of such recognition. The field of endeavor may be engineering design, applied illumination, optics, ophthalmology, lighting research, education or administration and management. Nominations and records from previous years, as reviewed and referred to the following year's committee, are given consideration along with new nominations.

Presentation of the 1959 Gold Medal, to Dr. N. A. Halbertsma of The Netherlands, was made during the CIE meeting in Brussels, this past June.

NEMA Reorganization Plan To Highlight November Meeting

Featured item on the agenda of the 1959 Annual Meeting of the National Electrical Manufacturers Association in Atlantic City, N. J., is the presentation and voting on plans for the reorganization of the 33-year old Association. The plan, if approved, will result in a new type of NEMA operation with annual conventions far different from the present Section-by-Section type meetings.

Reorganization plans will be presented at an all-NEMA business meeting on the afternoon of November 11, the second day of the convention. Other business to be transacted at this meeting includes presentation of the 1960 budget, nomination and election of members to the Board of Governors and a review of Section and Committee activity for 1959.

NEMA's 1959 Annual Meeting opens on Monday, November 9 and runs until Thursday, November 12. Program for the first two days is Section and Committee meetings, with several Subdivision parties planned for the evening of November 10. Presentation of the new officers at the Association's Annual Luncheon, scheduled for Thursday afternoon, will be the last item on the meeting program.

British IES Establishes Gold Medal Award

To mark its Fiftieth Anniversary, the British Illuminating Engineering Society (London) has instituted an award, to be known as the IES Gold Medal. Regulations governing the award are:

(1) The Medal shall be bestowed for outstanding contributions to the advancement of lighting.

(2) The Medal shall be awarded at intervals of not less than two years.

(3) Recipients of the Medal may be persons of any nationality and may or may not be members of the Illuminating Engineering Society.

(4) Nominations for the award may

(Continued on page 30A)

SCHEDULED EVENTS

September 25-26, 1959 — International Association of Electrical Inspectors (Canadian Section), Montreal, Que.

September 30-October 2, 1959 — Canadian Electrical Manufacturers Association, Sheraton-Brock Hotel, Niagara Falls, Ont.

October 5-7, 1959 — International Association of Electrical Inspectors (Western Section), Schroeder Hotel, Milwaukee, Wis.

October 5-10, 1959 — Society of Motion Picture and Television Engineers, Hotel Statler, New York, N. Y.

October 11-16, 1959 — American Institute of Electrical Engineers (Fall General Meeting), Chicago, Ill.

October 12-14, 1959 — International Association of Electrical Inspectors (Southern Section), Heidelberg Hotel, Jackson, Miss.

October 12-14, 1959 — National Electronics Conference, Inc., Hotel Sherman, Chicago, Ill.

October 12-16, 1959 — American Institute of Electrical Engineers, Fall General Meeting, Chicago, Ill.

October 13-14, 1959—National Technical Conference, Society of Plastics Engineers, Inc., Ambassador Hotel, Los Angeles, Calif.

October 19-22, 1959—International Municipal Signal Association, Stardust Hotel, Las Vegas, Nev.

October 13-15, 1959 — Electrical Progress Show, Convention Hall, Philadelphia, Pa.

October 15-17, 1959 — National Society of Professional Engineers (Fall Meeting), Olympic Hotel, Seattle, Wash.

October 19-20, 1959 — Annual Meeting of the United States National Committee (C.I.E.), Nittany Lion Inn, State College, Pa.

October 20-22, 1959 — Tenth National Conference on Standards, The Sheraton-Cadillac Hotel, Detroit, Mich.

November 2-5, 1959 — Eleventh Exposition of the Air-Conditioning and Refrigeration Industry, Convention Hall, Atlantic City, N. J.

November 9-12, 1959 — National Electric Contractors Association and Fifth National Electrical Exposition, Miami Beach, Fla.

November 9-13, 1959 — National Electrical Manufacturers Association, Traymore Hotel, Atlantic City, N. J.

November 17-19, 1959—Building Research Institute (Fall Conferences), Shoreham Hotel, Washington, D. C.

November 29-December 4, 1959 — The American Society of Mechanical Engineers, Chalfonte-Haddon Hall, Atlantic City, N. J.

January 12-15, 1960—The Society of Plastics Engineers, Inc., 16th Annual Technical Conference, The Conrad Hilton Hotel, Chicago, Ill.

January 25-28, 1960—Plant Maintenance Show, Convention Hall, Philadelphia, Pa.

January 31-February 5, 1960—American Institute of Electrical Engineers, Winter General Meeting, New York, N. Y.

February 22-25, 1960—National Rural Electric Cooperative Association (Annual Meeting), St. Louis, Mo.

February 25-26, 1960—Annual National Wiring Sales Conference, Warwick Hotel, Philadelphia, Pa.

March 6-9, 1960—Fifth Electrical Industries Show, New York City Coliseum, New York, N. Y.

March 23-26, 1960—Tenth Electrical Industry Show and Lighting Exposition, Shrine Exposition Hall, Los Angeles, Calif.

PROCEDURE . . .
for Discussion of Blackwell Research Paper, June 1959 IE, page 317

The Publications Committee calls attention to procedure, for members wishing to submit discussion of the important paper, "Development and Use of a Quantitative Method for Specification of Interior Illumination Levels on the Basis of Performance Data," by H. Richard Blackwell. For publication in ILLUMINATING ENGINEERING, discussion should be submitted not later than October 15, 1959, as follows:

One copy (original) to Miss Ruby Redford, Editor, ILLUMINATING ENGINEERING, 1860 Broadway, New York 23, N. Y.

One copy (for review) to Mr. Floyd W. Sell, Chairman, IES Papers Committee, Detroit Edison Co., 2000 Second Ave., Detroit 26, Mich.

One copy (for rebuttal) to Dr. H. Richard Blackwell, Director, Institute for Research in Vision, Ohio State University, Columbus, Ohio.

P. M. Rutherford, Jr., (right) Vice-President, Dallas Power & Light Co., accepts, on behalf of the Better Light Better Sight Bureau, the American Optometric Association's Award "in recognition of a quarter century of outstanding contribution to human welfare." Incoming AOA President, Dr. P. N. DeVere, presented the plaque to Mr. Rutherford during the 62nd Congress of the Association, held recently at the Statler-Hilton Hotel, Dallas, Texas.

(Continued from page 29A)

be made by any member of the Society in writing and in confidence, to the Honorary Secretary. Nominations will be considered by a Panel appointed by the Council and the Panel's recommendations submitted to Council by the President.

Nominations for the British Gold Medal award are now being sought, aiming at presentation of the first award during this Golden Jubilee year.

ABOUT PEOPLE

Ralph A. Huwe has been named manager of technical and engineering administration for General Electric's Ballast Dept., Danville, Ill. Mr. Huwe has been with G-E since 1951, serving in the Electronics Division, Aircraft and Ordnance Systems Dept., Thomson Laboratory and General Engineering Laboratory before joining the Ballast Dept.

Thomas Industries, Inc., Louisville, Ky., has announced the acquisition of C & M Products, Ltd., Toronto, Ont., fixture manufacturing company. **John J. Caragata,** president of the Canadian firm, will continue as head of the C & M subsidiary.

The Society of Plastics Engineers, Inc., has announced the appointment of **Melvyn A. Kohudic** as Editor of the *SPE Journal*, official publication of the Society, beginning with the September 1959 issue. Mr. Kohudic succeeds **Charles E. Rhine** who has resigned the SPE editorship to devote his time to *Graphic Science*, a new publication in the field of drafting and drawing administration.

J. E. Croushore, staff representative of the National Safety Council, Chicago, has been named Secretary of Sectional Committee Z35 of the American Standards Association. The Committee is studying specifications for accident prevention signs, a project sponsored by the National Safety Council.

Louis Duman, President of Advance Transformer Co., Chicago, has announced the completion of negotiations for Advance to join Consolidated Electronics Industries Corp., producers of electronically and electrically actuated machines for industry. The management of Advance will remain the same.

Duro-Lite Lamps, Inc., North Bergen, N. J., has announced the election of **Smith A. Goff** as president. Mr. Goff, formerly a vice-president of Duro-Test Corp., joined that organization in 1936 and was made v-p in charge of sales in 1956. Duro-Lite was recently organized by Duro-Test for the manufacture of residential lamps.

O. F. Klingsick, former vice president in charge of production for Day-Brite Lighting, Inc., St. Louis, Mo., is now serving as vice president and controller for the company, with responsibilities for accounting, budgeting, tabulating and costing. He will also be responsible for the Traffic Dept. In another announcement, Day-Brite named **Bernard J. Elfring** as sales representative for Vermont, New Hampshire and Maine, with headquarters in Portland, Me. For the past three years, Mr. Elfring has been engaged in sales and lighting layout work in the New York offices of the firm.

Prescolite Mfg. Co., Berkeley, Calif. has named **F. L. Green** as chief product design engineer. Prior to this appointment, Mr. Green was chief engineer with Shalda Mfg. Co., and was associated with S & M Lamp Co. as a design engineer.

A. M. Swasey has been appointed project leader for the newly created aviation and defense business unit at the General Electric Co. Outdoor Lighting Dept., Hendersonville, N. C. In this position Mr. Swasey will coordinate engineering, manufacturing and marketing of products for aviation and defense industries, including airport approach lighting, constant current transformers and controls and special purpose lighting for government purchase.

Better Light Better Sight Bureau has announced the appointment of **Charles E. Hoefler** as Assistant Bureau Manager. Mr. Hoefler joined BLBS earlier this year as assistant to Manager **Edward A. Campbell.**

Thomas A. Marshall, Thomas A. Marshall Associates, lighting consultants, Ft. Lauderdale, Fla., has been signed as

(Continued on page 63A)

NEW
K LITE
K-5

INVERTED
HEXAGONAL
PRISMATIC LENS PANELS

INVERTED FOR GREATER STRENGTH

ALL K-LITE LENS PANELS are exclusively extruded for standard modular installations in 1 x 2, 1 x 4, 2 x 2, and 2 x 4 units for 100% usage.

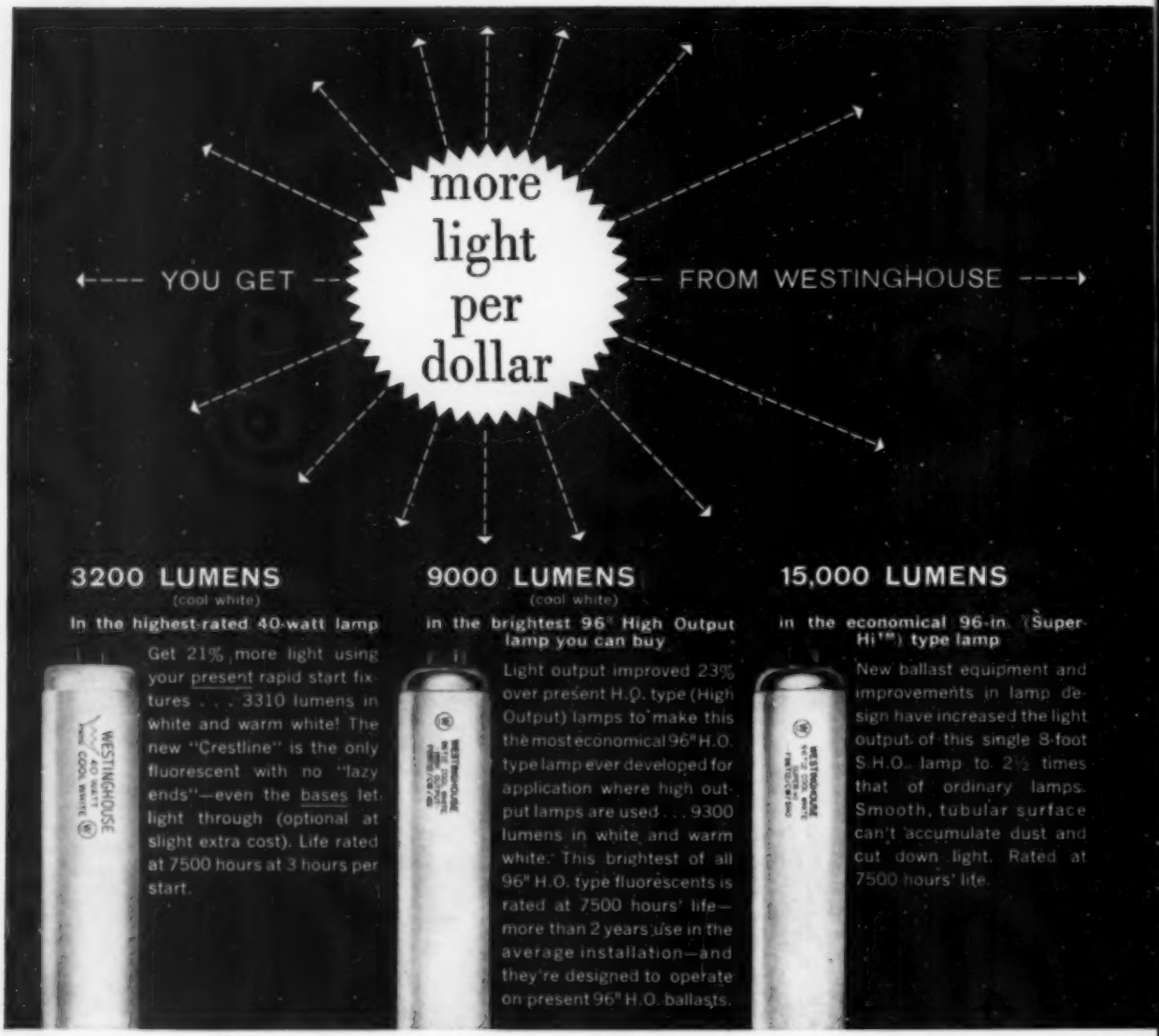
CALL YOUR nearby KSH executive-engineer for on-the-spot service and helpful engineering decisions . . . both indoor and outdoor lighting.

ATLANTA
CHICAGO • DAYTON
DETROIT • GRAND RAPIDS
INDIANAPOLIS • LOS ANGELES
MILWAUKEE • ST. LOUIS
SALEM (MASS.) • SAN FRANCISCO

from KSH PLASTICS, INC.
HIGH RIDGE, MISSOURI

NOW! *One new, brighter 40-watt lamp does the*

NEW "UNIVERSAL" PREHEAT-RAPID START LAMP


more light per dollar
YOU GET
FROM WESTINGHOUSE
3200 LUMENS
(cool white)
In the highest-rated 40-watt lamp
Get 21% more light using your present rapid start fixtures . . . 3310 lumens in white and warm white! The new "Crestline" is the only fluorescent with no "lazy ends"—even the bases let light through (optional at slight extra cost). Life rated at 7500 hours at 3 hours per start.
9000 LUMENS
(cool white)
in the brightest 96" High Output lamp you can buy
Light output improved 23% over present H.O. type (High Output) lamps to make this the most economical 96" H.O. type lamp ever developed for application where high output lamps are used . . . 9300 lumens in white and warm white. This brightest of all 96" H.O. type fluorescents is rated at 7500 hours' life—more than 2 years' use in the average installation—and they're designed to operate on present 96" H.O. ballasts.
15,000 LUMENS
in the economical 96-in. (Super-Hi™) type lamp
New ballast equipment and improvements in lamp design have increased the light output of this single 8-foot S.H.O. lamp to 2½ times that of ordinary lamps. Smooth, tubular surface can't accumulate dust and cut down light. Rated at 7500 hours' life.

job that two different types have been doing!

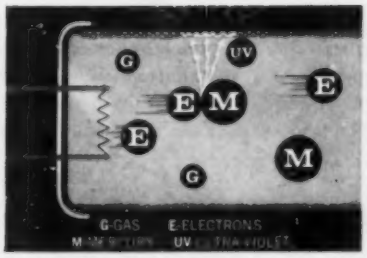
LUMENS
(COOL WHITE)

Simplify stocking, ordering and maintenance by specifying this one 40-watt fluorescent lamp for the job that two different types have been doing! The new Westinghouse "Universal" lamp can be used on either your present rapid start or preheat circuits with no loss in lumen output. You'll save storage space; save time and error in maintenance by stocking this one lamp.

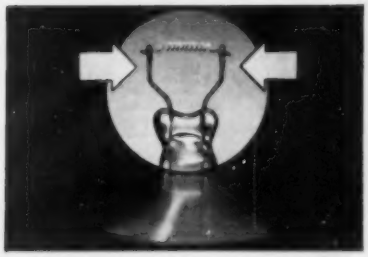
Whether you're planning or expanding, you can use this lamp in your new fixtures, as well as in your existing ones. And here's the best news of all: light output has been increased to 2800 lumens, while the list price has been *reduced* to only $1.25—5¢ less than old style rapid start lamps!

Only Westinghouse brings you these 6 LIGHT-BOOSTING ADVANCES

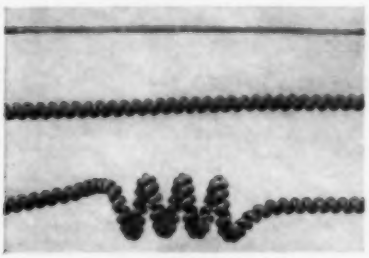
Ultralume™ Phosphors: Westinghouse research has proved that the size of the individual phosphor particles which coat the inside of a fluorescent lamp have a direct effect on the amount of light given off. Now, a new and exclusive Westinghouse process selects the right particle size for more efficient light-producing phosphors.



Mixed Gases: All fluorescent lamps contain mercury and gases. The gases serve as conductors until the mercury is vaporized. These gases and mercury vapor then convert electricity into ultra-violet radiation, which causes the phosphors to "fluoresce." Westinghouse uses the right mixture and pressure for each type of fluorescent lamp.



Plated Leads: The electron bombardment inside a fluorescent tube eventually causes particles of the metal supports and leads to sputter off causing "end blackening." To prevent this, Westinghouse plates the lead wires with super-hard chrome-vanadium. Result: tubes that *stay* brighter, end to end.



Triple Coiled Electrodes: Westinghouse uses triple wound electrode coils to hold the right amount of emission material. This carefully measured amount is heated quickly and adequately protected from bombardment to insure long life and trouble-free starting.

"Custom" Anodes: Anodes act as buffers and prevent excessive "sputtering" of emission material from the electrodes. Since the electrical characteristics are different for each type of fluorescent lamp, Westinghouse anodes are especially engineered to fit the electrical requirements of each type of lamp.

Silicone "Raincoats": In high-humidity areas, moisture can collect on the exterior surface of the lamp and prevent it from starting. To protect against moisture accumulation, Westinghouse fluorescents are given a special Silicone coating, or "raincoat," which disperses this film into harmless droplets.

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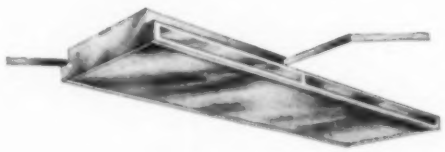

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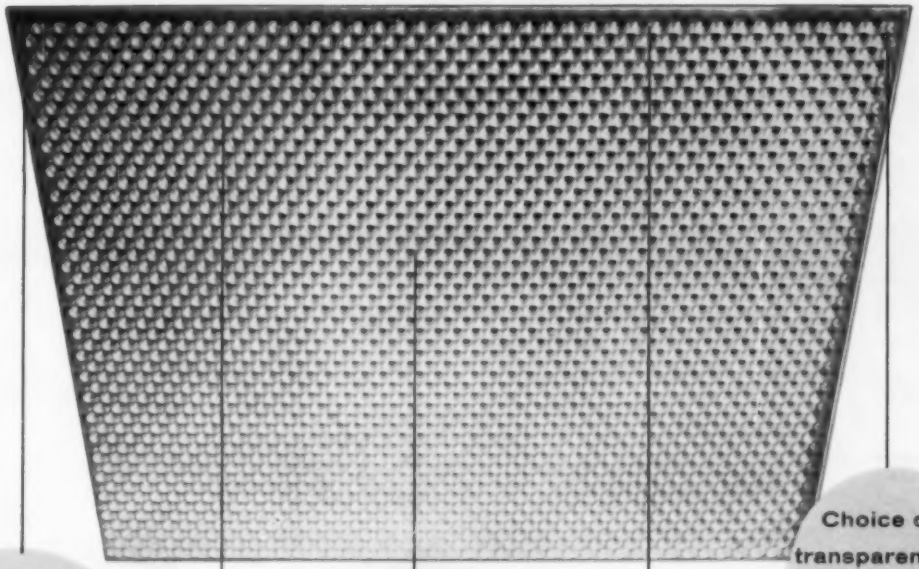

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Waterbury, Conn. *Richard L. Platt*

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Cornwall-on-Hudson, N. Y. *Eugene Littman*

Line Material Co.
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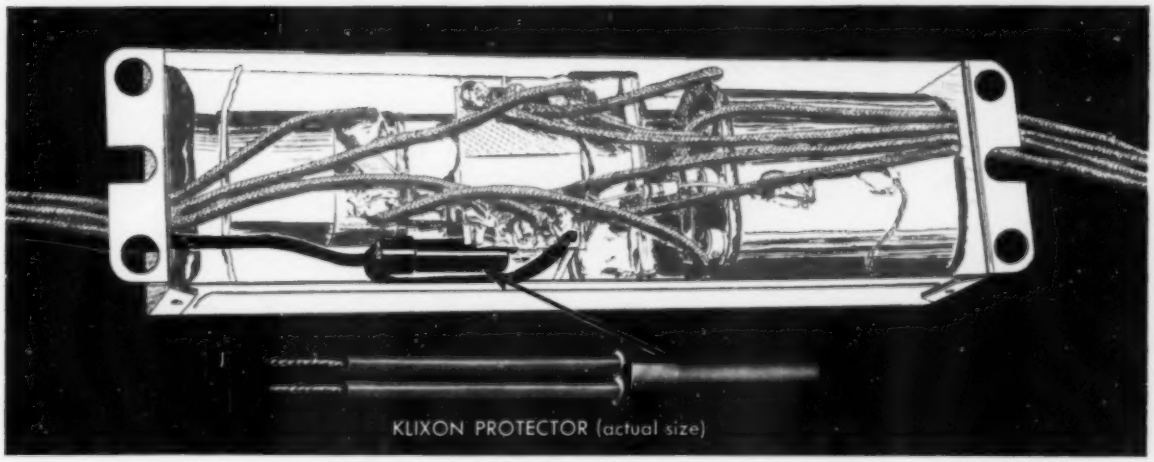
Milwaukee 1, Wis. *M. C. Harsh*

(Continued on page 40A)

Built-in KLIXON Protectors in Ballasts

ELIMINATE DRIPPING COMPOUND, VIOLENT FAILURES, FIRES . . .



KLIXON PROTECTOR (actual size)

Hold safe operating Temperature under adverse conditions!

Here's How KLIXON Protectors Operate!

Klick it's "off"

When a fault condition causes temperature to rise above safe operating level.

Klick it's "on"

When ballast cools to safe temperature.

Why put up with dripping compound, fires, or violent failures when you can get complete overcurrent *and* overheat protection by using ballasts with KLIXON Protectors?

Because built-in KLIXON Protectors keep ballasts operating within a safe temperature range, they safeguard ballasts against all conditions, such as — one lamp out, poor heat dissipation, lamp rectification, internal short. KLIXON-protected ballasts assure maximum light output under all fault conditions until ballast reaches a temperature where continued use would cause reduction in insulation life. It then turns the current off and allows the ballast to cool until it is safe to continue operation. Then it turns the current on allowing the ballast to operate again until temperature exceeds the maximum safe limit. There is no annoying flicker since the fixture cooling period lasts 30 to 45 minutes.

If the cause of over temperature is *external* to the ballast, normal ballast life can be expected when the fault has been corrected. If the cause is failure of a component *in* the ballast, it is necessary to replace the ballast. However, temperature limits are held to a safe level until it is convenient to make this change.

Write for specification details.

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5409 FOREST STREET, ATTLEBORO, MASS., U. S. A.

A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

SPENCER PRODUCTS: Klixon® Inherent Overheat Motor Protectors • Motor Starting Relays • Thermostats • Precision Switches • Circuit Breakers

(continued from page 38A)

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Northern States Power Co.
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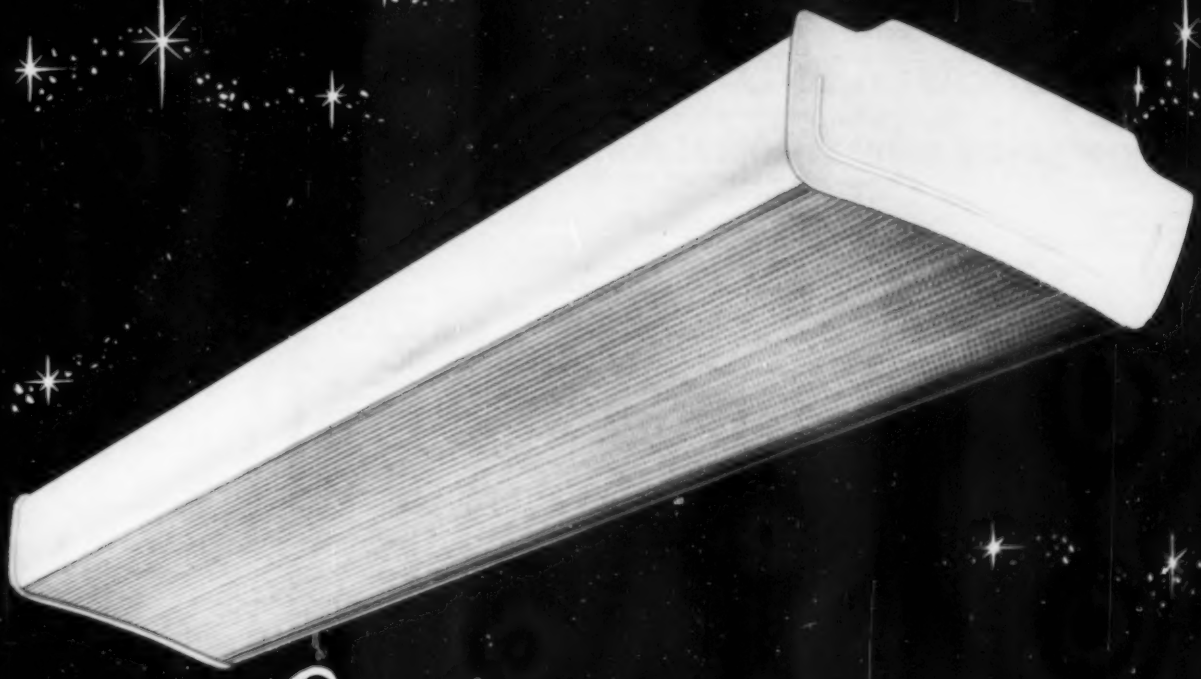
1260 Pennsylvania Ave.
San Francisco, Calif. *R. K. Meyer*

Pacific Gas & Electric Co.
245 Market St.
San Francisco 6, Calif. *O. R. Doerr*

(Continued on page 42A)



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AVAILABLE NOW AT A LOW-BUDGET *Price*

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Diffuse white sides prevent objectionable side brightness

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Shield hangs down from either side on continuous hinge

Two-lamp unit (illustrated) is less than 9″ wide, 3¼″ deep

Exact 48″ length; joins end to end quickly and easily

Write for Bulletin 59

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DIV. OF GARDEN CITY PLATING & MFG. CO.
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(Continued on page 44A)

Only Sylvania VHO POWERTUBES*

give you all of these Very High Intensity lamp advantages!

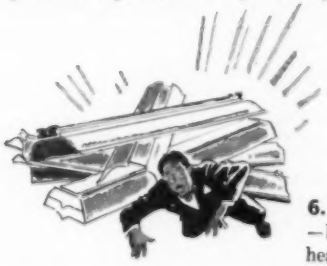
1. More than twice as much light as obtainable from standard fluorescent lamps of same size.

3. Easier to handle than competitive high intensity lamps . . . Sylvania VHO POWERTUBES weigh half as much as other shapes.

2. Smooth surface—the preferred tubular shape that does not catch and hold dust.

4. Smaller in size —T-12 1½" tube diameter permits better air circulation around the tube than larger diameter lamps.

5. Lower in cost—less expensive to buy and install, provide more lumens. The 8-foot, 200-watt VHO POWERTUBE, for example, delivers 15,000 lumens! Easier to stay clean, quicker to wipe clean than special shape lamps.



7. Uniform light distribution delivers full light output in any position.

8. Better optical control permits full use of light directed exactly where you want it.

6. Does not require "oversized" fixtures —helps keep fixtures costs down, avoids heavy tube strain on fixtures.

And only Sylvania Fluorescent Lamps are backed by the exclusive Sylvania Light Insurance Policy!

Guaranteed by Sylvania, the Policy specifies if, in your opinion, Sylvania's lamps do not perform better than the brand you are now using, you may return them to our distributor and get your money back.

*Trademark

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Salem, Massachusetts
In Canada: Sylvania Electric (Canada) Ltd.
P. O. Box 1190, Station "O", Montreal 9

SYLVANIA GENERAL SYSTEM
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

(Continued from page 42A)

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Sunbeam Lighting Co.
777 E. 14th Place
Los Angeles, Calif. — *Herbert L. Krieger*

Sun-Lite Manufacturing Co.
2555 Bellevue Ave.
Detroit 7, Mich. — *Fred Binder*

Sun-Ray Fluorescent Co.
2025 So. Michigan Ave.
Chicago 16, Ill. — *Jerome Gimbel*

The Superior Electric Co.
83 Laurel St.
Bristol, Conn. — *William P. Carpenter*

Supreme Lighting Co.
600 Turner St.
Los Angeles 12, Calif. — *Frank Blackwell*

Sylvania Electric (Canada) Ltd.
6233 Cote de Liesse Road
Montreal, Que. — *F. W. Fulle*

Sylvania Electric Products Inc.
60 Boston St.
Salem, Mass. — *W. P. Lowell, Jr.*

Tampa Electric Co.
Cass & Tampa Sts.
Tampa 1, Fla. — *W. C. MacInnes*

Tarnow Electric Supply Co.
45 E. Milwaukee Ave.
Detroit, Mich. — *Nathan Tarnow*

Frank C. Toal Co.
3222-24 E. Jefferson
Detroit 7, Mich. — *Harold C. Smith*

Terreau-Racine Ltee.
196-228 St. Paul St.
Quebec, Que. — *Georges Langlais*

Texas Electric Service Co.
Electric Bldg., Ft. Worth 1, Texas — *O. G. Carlson*

Texas Power and Light Co.
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Dallas 22, Texas — *Bassett Watson*

Thompson Electric Co.
P. O. Box 873
Cleveland 22, Ohio — *Robert K. Farrington*

Thompson-Wilson Co.
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Atlanta, Ga. — *H. L. Wilson*

Toledo Edison Co.
Edison Bldg., Toledo 4, Ohio — *William R. Poole*

Toronto Hydro-Electric System
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Toronto 2, Ont. — *Wilson J. Wylie*

B. M. Tower Co., Inc.
Dewey St., Bridgeport, Conn. — *Harvey N. Tower*

Trans-Lite, Inc.
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Union Electric Co.
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Universal Mfg. Corp.
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Salt Lake City 10, Utah — *D. H. White*

John C. Virden Co.
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Virginia Electric & Power Co.
Richmond 9, Va. — *W. I. Dolbeare*

Voigt Co.
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Cambridge 38, Mass. — *M. C. Kirkpatrick*

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Westinghouse Electric Corp., Lamp Division
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Westinghouse Electric Supply Co.
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Wheeling Electric Co.
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Edina 10, Minn. — *Donald D. Olson*

White Way Electric Sign & Maintenance Co.
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4246-48 Milwaukee Ave.
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R & W Wiley Inc.
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108 S. Main St.
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Wilmet Castle Co.
P. O. Box 629
Rochester 2, N. Y. — *E. H. Greppin*

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280 Lakeshore Rd.
Toronto, Ont. — *J. Carl Wilson*

The Windsor Utilities Commission
Hydro Division
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The Wiremold Co.
Hartford 10, Conn. — *Robert H. Murphy*

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Wisconsin Power & Light Co.
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Wisconsin Public Service Corp.
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Worcester County Electric Co.
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Worcester 3, Mass. — *Donald S. Bennett*

Work-O-Lite Co.
522 Cortlandt St.
Belleville, N. J. — *Jack Siegel*

Zenith Electric Supply Ltd.
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Five distinctive features

make this new VIRDEN Commercial Fixture

Your Best Buy!

1. **Easy to maintain**
   Removable side panels. No tools required. Suspended units can be relamped from above or below. Safety chain suspends louvres out of the way, freeing both hands for maintenance.

2. **Simplified continuous row installations**
   3/16″ matching K.O's. in end plates eliminate connectors. Rectangular K.O's. provide extra large wireway for easier wiring. For stem mounting, mounting plates have preset screws, slip into key holes in channel.

3. **Complete mounting accessories**
   Including rigid and swivel stems plus special 1½″ on-ceiling outlet box to comply with national code.

4. **Choice of 35° x 25°, 35° x 45°, or 45° x 45° shielding**
   Available in metal or polystyrene plastic side panels.

5. **Virden quality throughout**
   Die stamped steel. Bonderized finished in white high-baked enamel.

The new Virden Commercial fixtures meet all present day standards for school lighting. Also ideal for offices, stores, commercial installations. Available in 2-light rapid start and slimline, 4 and 8 foot lengths. Also in 4-light tandems, rapid start, 8 foot lengths.

See them at your Virden distributors now! Or write for Form No. 146 to Virden Lighting, Dept. IE, 5209 Euclid Ave., Cleveland 3, O.

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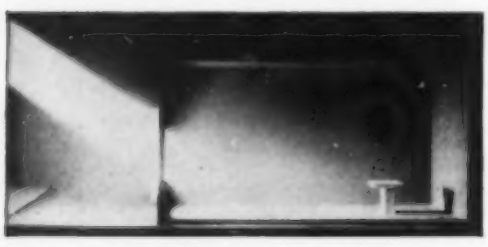
TAILORING LIGHT...
TO SUIT YOUR NEED

The property of light diffusion in translucent glass by Mississippi is one of the most useful tools available to the illuminating engineer. By its means rooms can be adequately daylighted far from windows, small skylight areas can cover large expanses of floor space with shadowless daylight, privacy can be secured, light can be controlled . . . literally tailored to suit your particular requirements.

Working hand in glove with modern lighting practices, Mississippi Glass reduces contrast that results in costly visual errors . . . keeps interiors more comfortable. Occupants see better, feel better, work better.

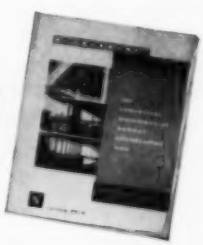
CLEAR GLASS—Actual photograph of "smoke box room" with its window glazed with clear glass. Note high concentration of light near window.



DIFFUSING GLASS—Smoke box photo—window glazed with diffusing glass. Note uniformity of lighting and its distribution to far side of room.

In these photographs the box is built to a scale of 1"=1' to represent a room 12' high, 12' wide and 24' deep. The "window", centered in one end, is 4' square, 3' above the floor.

Available at your quality glass distributor in a wide variety of patterns and surface finishes for industrial and commercial buildings, schools and residential use. Make the most of light. Specify Mississippi Glass.



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Contains pattern descriptions, light distribution charts, and transmission data.
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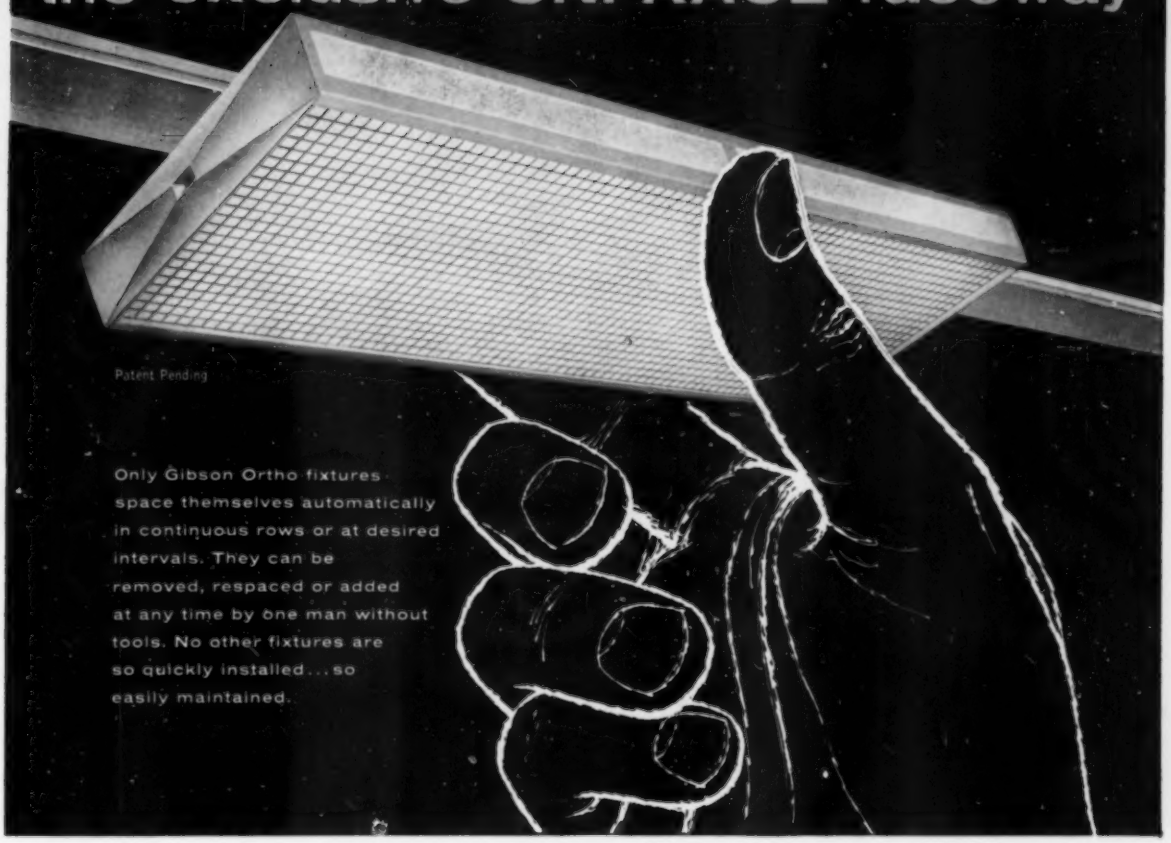
WORLD'S LARGEST MANUFACTURER OF ROLLED, FIGURED AND WIRED GLASS

GIBSON ORTHO 66

the fixture that just plugs in on the exclusive UNI-RACE raceway



Patent Pending

Only Gibson Ortho fixtures space themselves automatically in continuous rows or at desired intervals. They can be removed, respaced or added at any time by one man without tools. No other fixtures are so quickly installed... so easily maintained.

installation quick and simple

1 Uni-Race, U.L. approved raceway of 225-amp capacity, is assembled and wired on floor.

2 Light, rigid Uni-Race assembly up to 48' easily lifted and hung.

3 Fixtures simply snap into place. Plug in fixture engages receptacle in Uni-Race.

WRITE FOR COMPLETE INFORMATION ABOUT THE GIBSON ORTHO LINE

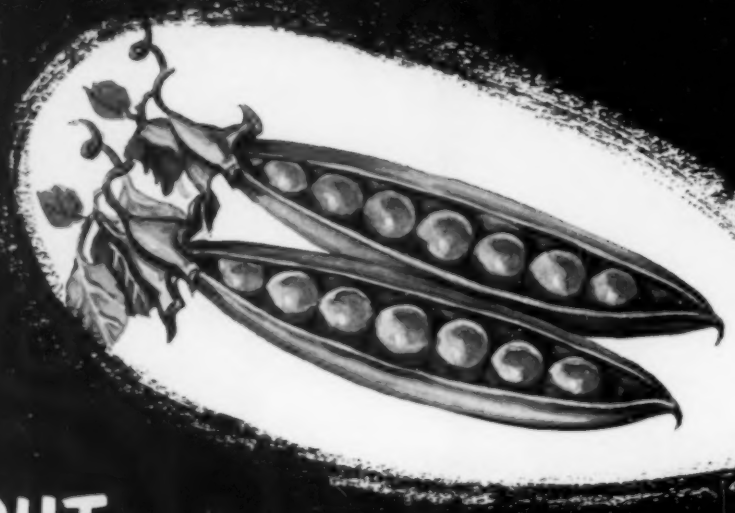
Gibson LIGHTING

GIBSON MANUFACTURING COMPANY

1919 PIEDMONT CIRCLE, N. E. ATLANTA 9, GEORGIA

Manufactured in Canada under franchise by Electroller Manufacturing Co., Ltd., Montreal

They LOOK alike...



BUT...

Most peas look alike, but their quality can vary greatly. So it is with lighting standards. Two steel standards may look the same, but only Kerrigan standards have these plus values:

1. Superior strength, with stronger bracket connections
2. Heavier wall thickness (.130)
3. More resistance to bending—less deflection
4. Drop forged steel anchor base
5. 4 to 6 times greater resistance to corrosion
6. Guaranteed high yield point
7. One continuous longitudinal weld—Magnafluxed
8. Octagon shape—Inherently stronger than the round or fluted
9. Trim, modern lines, architecturally correct

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KERRIGAN
IRON WORKS COMPANY
Nashville, Tennessee

For better lighted streets and highways the STANDARD is KERRIGAN!

LPI Troffer Reference Guide cross-indexes 64 different ceiling types with a wide line of recessed troffers. Simply find the type of ceiling specified, then choose the proper LPI fluorescent troffer to match the ceiling. Selection takes only seconds, and you're always sure of a trouble-free installation.

LPI Reference Guide selects right troffer to match any ceiling

LPI offers a Troffer Reference Guide to help you select the correct fluorescent troffer to fit any one of 64 widely used types of ceilings. This handy guide tells you quickly and accurately — without guesswork — which troffer is suitable and workable for your job. This handy selection guide can save you hours of thumbing through catalogs, as well as reduce merchandise handling and eliminate costly returns.

The Troffer Reference Guide is an added service of Lighting Products Inc., manufacturers of premium quality fluorescent fixtures. Send for your copy.

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LPI FLUORESCENT LIGHTING

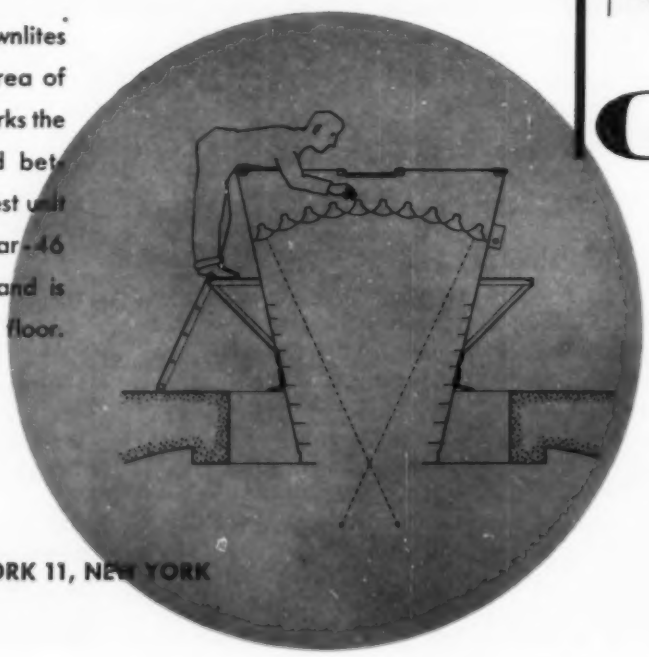
RAMBUSCH

LIGHTING

ARCHITECT: ALBERT F. ROLLER • ELECTRICAL ENGINEER: LYLE E. PATTON

CALIFORNIA MASONIC MEMORIAL TEMPLE, SAN FRANCISCO, CALIFORNIA

Six Rambusch Multi-Lamp Downlites* are used to light the center area of the room shown above. This marks the introduction of a "bigger and better" downlite. So far, the largest unit made houses 96-300 watt Par-46 lamps (total load 28.8 KW) and is mounted 170 feet above the floor.



40 WEST 13TH STREET, NEW YORK 11, NEW YORK

*TRADEMARK

ONE OF THE EARLIEST LIGHT SHIELDS

Its chief advantage: the Boss couldn't tell when you were sleeping.

Its biggest disadvantage: it worked only for the one individual who wore it...and not too effectively at that.

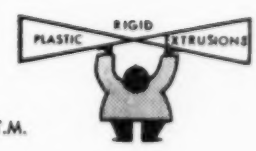
But now... with the fixtures and the lamps already on the market and with the newer ones continually being developed to meet Blackwell recommendations, better shielding is a "must."

Today plastics offer a combination of exceptional advantages unavailable in older materials for shielding, diffusing or controlling light. And when you think of plastics, think of *extruded plastic* as the efficient way to achieve modern shielding.

Low brightness prismatic panels (such as our EXTRU-LITE®), large wrap-around enclosures or just plain side-panels—it makes no difference, extruded plastics by Rotuba cost no more. YET YOU CAN BE SURE they are made with the finest materials obtainable. Experienced supervision and quality control go into the manufacture of each and every part that leaves our plant in a pre-tested and approved shipping carton.

REMEMBER ROTUBA —
THE NAME YOU CAN DEPEND ON FOR MODERN SHIELDING

Manufacturers will want to have our newest Mailer. It shows *in actual size* a wide variety of shapes being made for lighting and gives design suggestions to consider when planning new shapes. Write for it today.



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A DIVISION OF WALJOHN PLASTICS, Inc.
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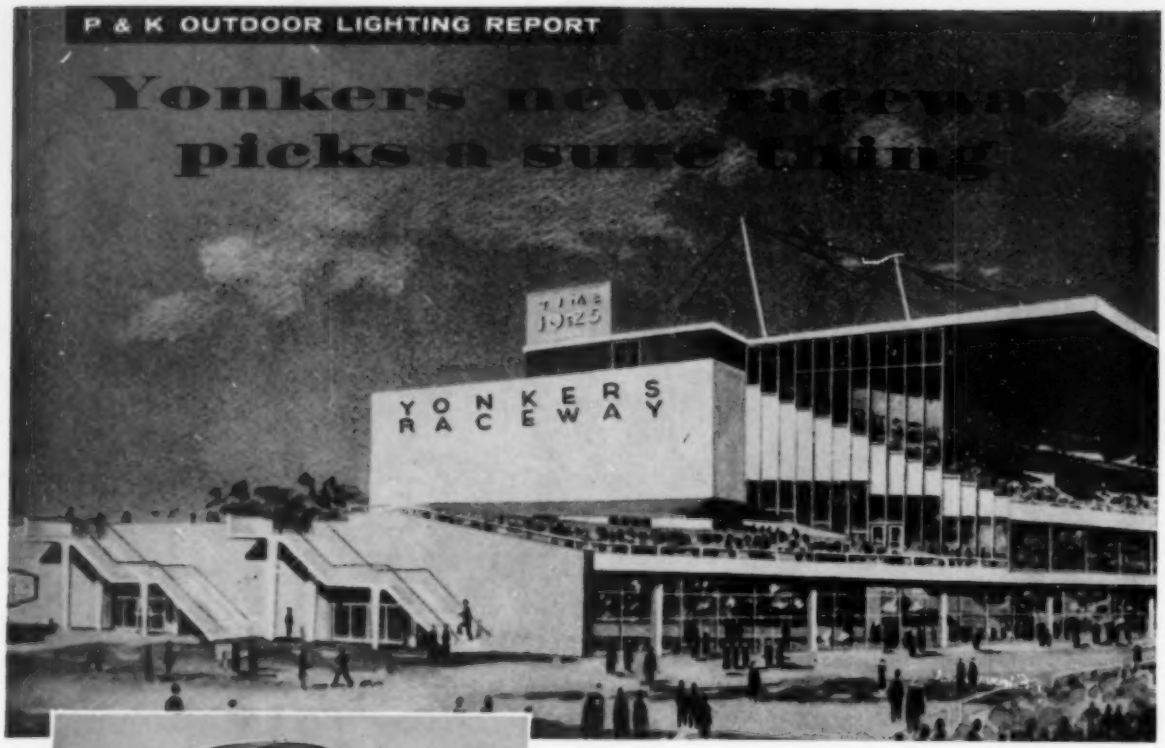
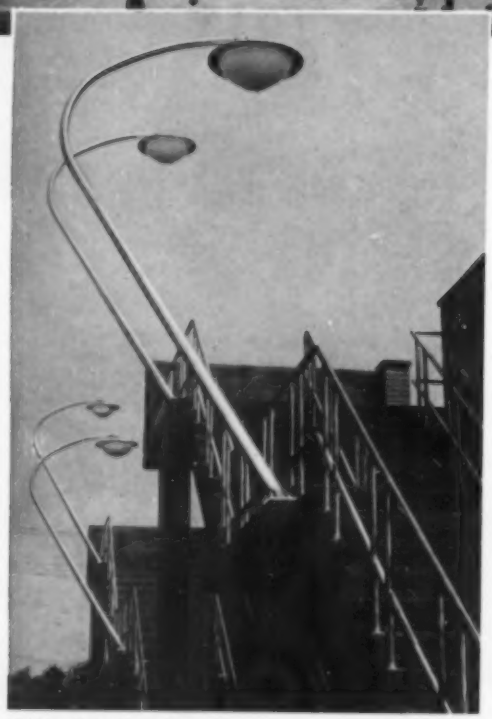
P & K OUTDOOR LIGHTING REPORT

Yonkers new raceway picks a sure thing





Architect: Lionel H. Levy, N. Y.
Electrical Consultant: Guy P. Panero, N. Y.
Electrical Contractor: Fischbach & Moore, Inc., N. Y.

P&K CIRCLElux DAVITS LIGHT THE WAY

Here, at the country's newest and most luxurious track, P&K all-aluminum CIRCLElux davit-style lighting standards were chosen. Their natural functional beauty add a modern complement to the surroundings. For example, the units illustrated are 10 foot gracefully arched davits with our CIRCLElux fluorescent luminaire. CIRCLElux incandescent luminaires were used in other applications at the raceway.

The wide range of styles available, along with the choice of three lighting sources—incandescent, fluorescent, and mercury vapor—enables you to effectively customize any installation with a "package" unit, standard and luminaire, complete and ready for installation. This means easier specifying and easier installation, and it is good to know that P&K aluminum standards never require painting or other costly maintenance, keep their good looks for years and years.

For more facts send for bulletin LTG-30 describing the complete range of CIRCLElux lighting packages.

P&K

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IN CANADA: POWERLITE DEVICES, LTD., TORONTO, MONTREAL, VANCOUVER

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Why Lustrex Perma Tone Styrene for ceilings?

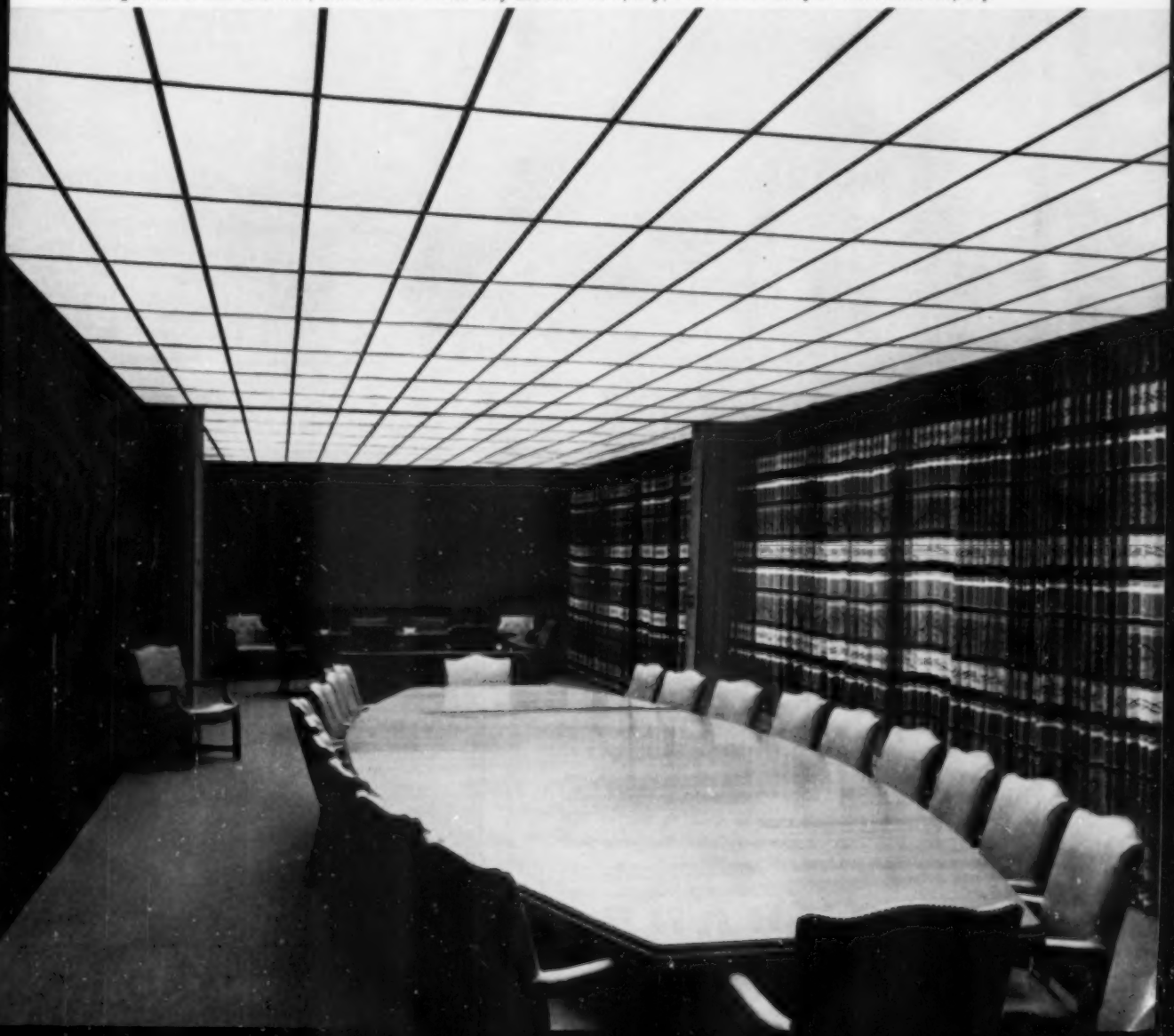
3 times more resistance to yellowing that's why! Perma tone was specially developed to meet IES-NEMA-SPI joint specifications for ultra violet light stabilized styrene—exceeds the requirements of these specifications. ▪ Truly translucent whites and a wide range of colors. ▪ Uniform light distribution characteristics. ▪ Large areas of illumination, good diffusion. ▪ Light weight for easy handling, installation, and maintenance. ▪ Dimensionally stable. ▪ Low cost.

FOR FREE TECHNICAL REPORT on Lustrex perma tone styrene, including accelerated test results and other valuable data on styrene in lighting fixtures, write to Monsanto Chemical Company, Plastics Division, Room 1319 Springfield 2, Mass.

Monsanto

LUSTREX: REG. U. S. PAT. OFF.

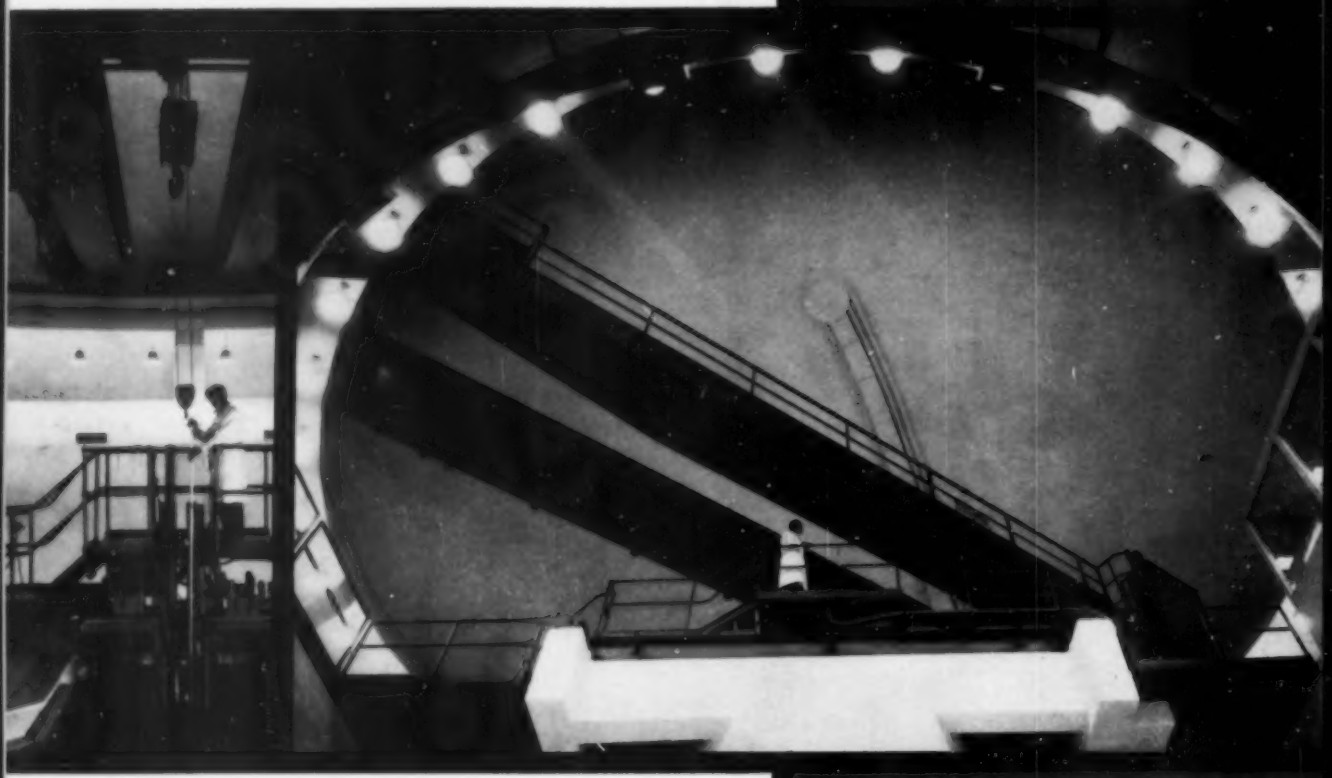
GRATELITE Louver-Diffuser by Edwin F. Guth Company, St. Louis, in conference room of the American Dental Association, Chicago, Illinois. Molded of Lustrex perma tone styrene by Koller-Craft Plastics Products, Inc., Fenton, Missouri. Architect and Engineer: Childs & Smith; Contractor: White City Electric Company; Distributor: Graybar Electric Company.



Holophane Lighting

Keeps Pace with the Advances of Industry

SKIDMORE, OWINGS & MERRILL, Architects
GUY B. PANERO ENGINEERS, Cons. Engrs.
EMERSON-GARDEN ELECTRIC CO., Contractors



LOBAY Mercury Reflectors Light Industrial Reactor Laboratories

Twelve important companies have coordinated their resources for experimenting with nuclear radiation in industry at Industrial Reactor Laboratories, Plainsboro, N. J. . . . HOLOPHANE LOBAY Prismatic Reflectors were selected to light the pool reactor area because they provide many unique advantages. Their deep shielding prevents reflection from the pool. Prismatic design produces high level illumination with low brightness. At the same time, their upward component affords balanced, overall luminosity. Excellent light distribution permits best control of the reactor in the shaft . . . One more example of the way that HOLOPHANE controlled lighting meets specific needs.

HOLOPHANE
COMPANY, INC. • *Lighting Authorities Since 1898*
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Holophane
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LOBAY®

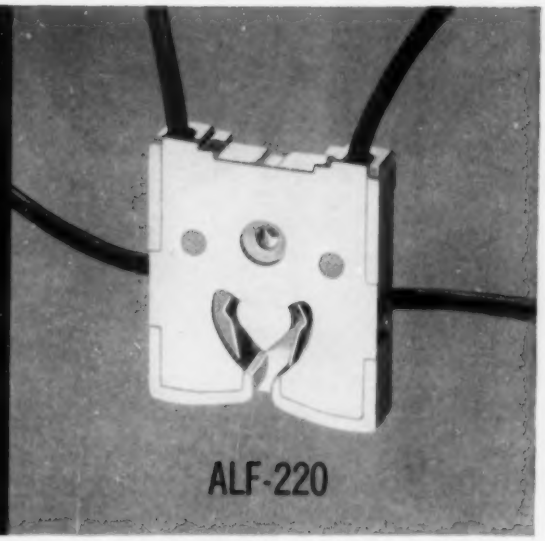
You are invited to consult HOLOPHANE engineers through your professional advisors.

NOW! You can wire and mount fluorescent lampholders faster, at lower cost than ever before!

General Electric announces

NEW THIN PRESSURE-LOCK LAMPHOLDER

for medium bi-pin lamps



Here are the time-and-money saving benefits that make this new General Electric lampholder the biggest thing in years for manufacturers of fluorescent lamp fixtures:

- **Faster, easier wiring!** Exclusive General Electric pressure-lock termination allows simple insertion of tinned leads; spring holds them in place firmly. Result: faster wiring that cuts assembly.
- **Double connection for each contact!** Permits top or side wiring or jumper connection for rapid start circuits.
- **Easy removal of wires**—when you want—is provided by wire release slots built in at each connection.
- **Fast single-screw mounting!** Lampholder mounts with one #6 screw. Anti-rotation slot and bosses provided on back and top of lampholder.
- **Minimum back-to-back dimension!** This new design provides for $47\frac{15}{16}$" mounting for 48" modular fixture length.
- **Ideal for modern fixture design!** The combined features of size, wiring connections and mounting make this lampholder unsurpassed in versatility. Standardizing on this lampholder will simplify your stocking and ordering problems.

Free sample and descriptive literature will show you in greater detail how General Electric's new pressure-lock lampholder can help you to lower-cost wiring and mounting. Rating: 660 watts, 600 volts, UL Approved. Mail coupon today!

Progress Is Our Most Important Product

GENERAL ELECTRIC

Marketing Section, Accessory Equipment Dept.
General Electric Co., 1285 Boston Ave.
Bridgeport 2, Conn.

Please send me free sample and descriptive literature on new G-E pressure-lock lampholders.

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Meet Special Lighting Problems in Special Ways...

with STANDARD SYLVANIA FIXTURES

Every so often a lighting situation develops that just cannot be answered by conventional methods.

Take the installation shown above as an example. Here is a shop where precision machine work is performed daily. Lighting requirements call for effective vertical illumination on the key surfaces of intricate tools as well as even, high level horizontal lighting. Reflected glare from the polished surfaces must be kept at a minimum and shadows should be practically non-existent.

To meet the lighting requirements under these challenging circumstances, Sylvania engineers recommended a louvered fixture with 35° x 45° shielding and plenty of up-light to achieve two purposes . . . to eliminate unsatisfactory contrast between the fixtures and the ceiling background; and to achieve effective uniformity of illumination throughout the entire area. Very high output (1500 ma.) lamps were used to produce the 150 foot-candle level desired. And a special grid-type layout was used to provide lighting on vertical surfaces from all directions.

The result, as shown above, is uniform, high level lighting where workers perform efficiently in complete comfort. Production efficiency has increased and rejected parts have been reduced considerably.

This illustrates why it pays to check with Sylvania when a lighting problem confronts you. Sylvania's complete line of fluorescent fixtures . . . both industrial and commercial . . . gives complete freedom in selecting the exact fixture that will solve your problem best.

From now on, take your lighting problems to Sylvania . . . where good lighting is a science.

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A Division of SYLVANIA ELECTRIC PRODUCTS INC.
Department 59-8
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FLUORESCENT LIGHTING FIXTURES AND SYSTEMS • BEST FIXTURE VALUE IN EVERY PRICE RANGE

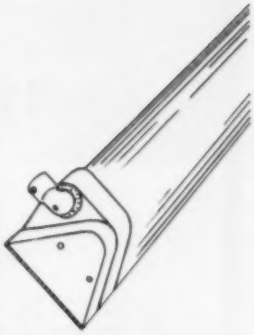
Revere Outdoor Lighting Report

Revere ELECTRIC MFG. CO.

Lighting a truck loading dock

The Problem: To light the entrance of a trucking depot loading dock. Light level must be high enough for safety and for precise parking of large trucks.

The Answer: Revere Fluoresign Outdoor Luminaires were installed over the doorways insuring safety, security and providing ideal visibility. This made nighttime parking as safe, fast and easy as daylight parking. The depot's eight entrances and its entranceway were lighted at the level of 12 to 15 footcandles with the all-weather fluorescent luminaires. Adjusting Fluoresign for best light spread can be done with lamps in and burning.

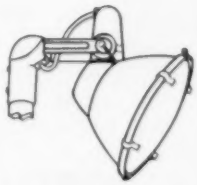


No. 8650 Series
Fluoresign Outdoor Luminaire

Lighting a tennis court

The Problem: To make night tennis play possible by providing the high level of uniform light required for good visibility in this high-speed game.

The Answer: Revere 4200 series floodlights mounted on Revere hinged poles were installed to provide the high level of light desired. Poles down the center of the courts have four floodlights, directed in pairs toward adjacent courts. Poles around perimeter of the court area have two floodlights each. Mounting height for all floodlights is 30 ft. Installation gives average maintained illumination of 13 footcandles.

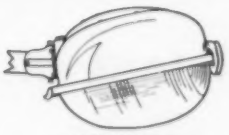


No. 4200 Series Floodlight

Lighting a shopping center parking lot

The Problem: To illuminate a large parking lot for safety in driving and parking, ease in locating parked cars, and to make the shopping center look more inviting.

The Answer: Revere Endoval Mercury Luminaires were used to illuminate driving lanes, and Revere No. 3350 Series Floodlights were installed to provide high-level illumination of 1.1 average maintained footcandles for the parking areas. The equipment is mounted on Revere hinged poles, using Revere brackets and arms. The hinged poles permit easier, safer, and more economical maintenance and relamping from the ground. Pole spacing is 150 ft.



No. 2282 Endoval
Mercury Luminaire

No. 3350 Series Floodlight

Write for Revere's complete catalog of outdoor lighting equipment

Revere ELECTRIC MFG. CO.

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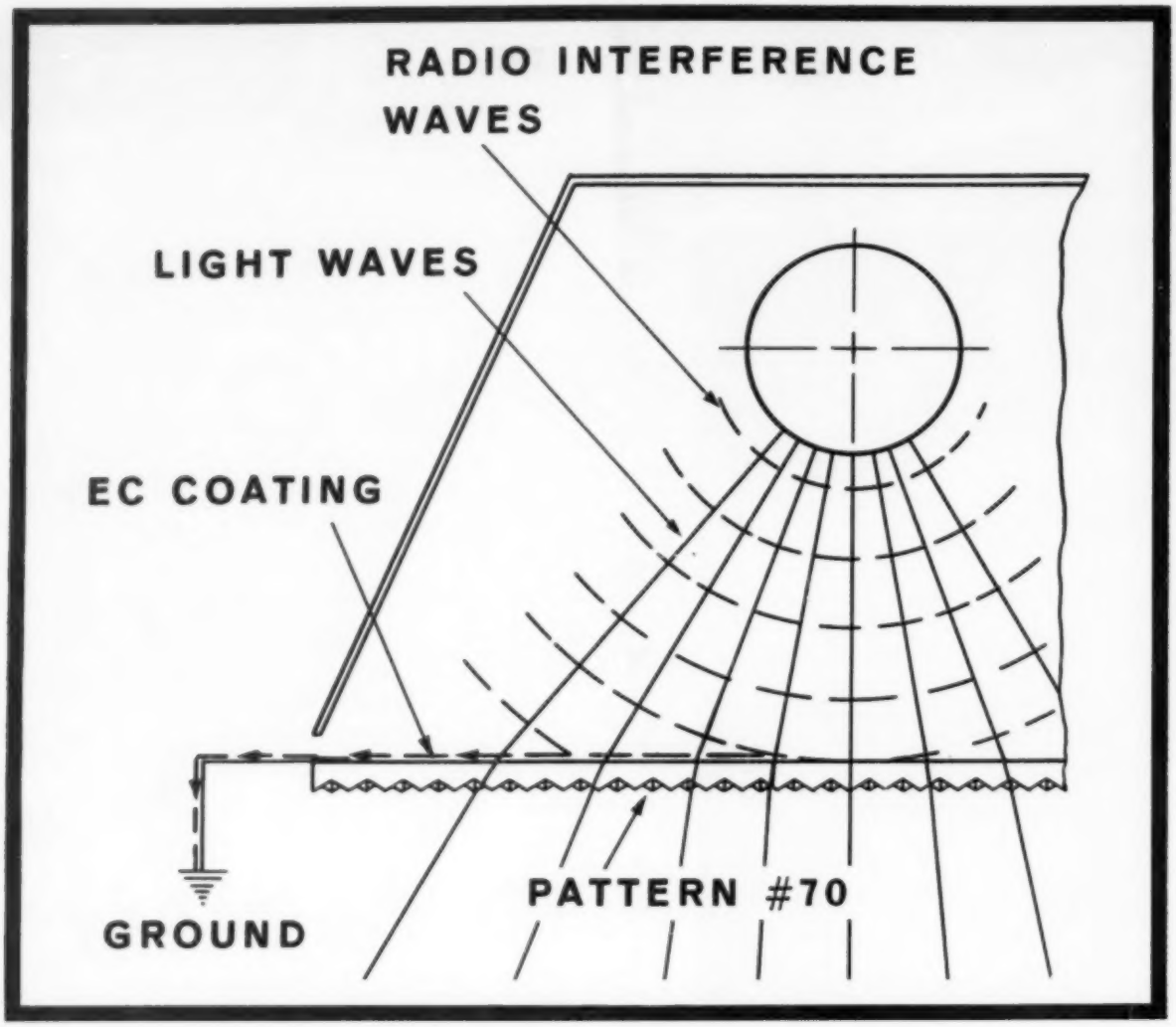

PYREX® E-C coated pattern No. 70 stops radio interference from fluorescent lamps

Radio interference radiated from hot cathode fluorescent lamps ceases to be a problem when you put them in back of a panel of PYREX E-C coated pattern No. 70. Everything radiated in the range of .018 to 25 megacycles is stopped at the surface of the PYREX panel—and yet the panel effectively transmits 70 to 78% of the open troffer illumination.

This new panel is the perfect answer for those situations where brightness must be controlled yet where radiated interference cannot be tolerated. Hospitals where electronic apparatus of any kind is being used, research laboratories, radio stations, and radio stores can all use this glass.

Brightness is controlled by an over-all pattern of uniformly distributed hexagonal pyramidal prisms. The panel can be cut to any desired shape or size.

Radiation is controlled by a hard, scratch-proof coating of electrically conductive film permanently fused to the glass. A ¼-inch-wide metal grounding strip is fused to the film around the edge of the glass.

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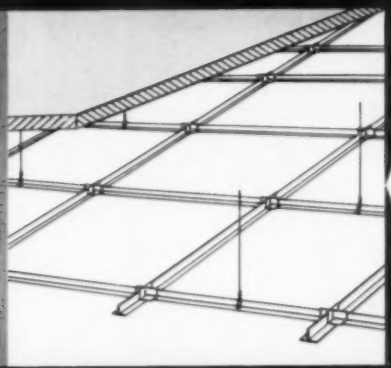
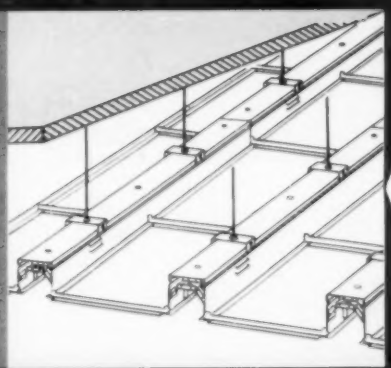


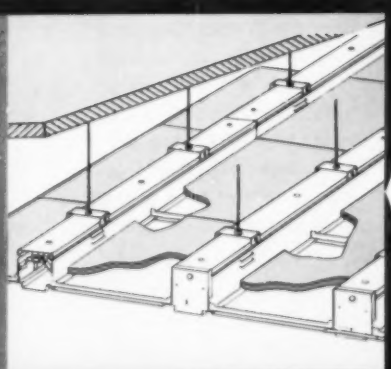
2

The lighting is suspended on this framework.



3

Acoustical panels are also suspended on this framework.



Quiet-Light

reverses the procedure and eliminates this step

1

QUIET-LIGHT recessed troffers are suspended by slide grip hangers, wall angles are mounted, and spacer bars inserted.

2

Acoustical panels are suspended on the framework created by the **QUIET-LIGHT** troffers, spacer bars and wall angles.

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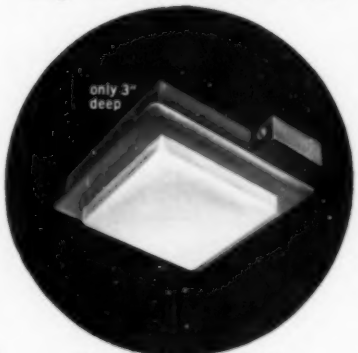

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Moldcast fixtures are designed to fully enclose the sealed beam spot and reflector lamps, thus eliminating the back halo of light seen with exposed lamps, and directing the beam with maximum intensity where it is desired.

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MOLDCAST manufacturing company

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(*Continued from page* 30A)

southeastern Florida representative for LAM, Inc., Wakefield, Mass. structural lighting firm. Mr. Marshall was formerly associated with the Edwin F. Guth Co. in their Cincinnati offices and prior to that he was with Sylvania Electric Products in Detroit.

Florida Power Corp., St. Petersburg, Fla., has announced the promotion of **William B. Shenk** from general sales manager to vice president in charge of sales. Mr. Shenk has been in utility sales for over 29 years, serving with both Florida Power and the Virginia Public Service Co. He was Charter Chairman of the Florida Chapter (now Section) of IES.

William Weibel, formerly with Curtis Lighting, Inc., Chicago, is now associated with Revere Electric Mfg. Co., also of Chicago. In his new connection, Mr. Weibel is working on engineering design and development of lighting equipment, under Revere's chief engineer, **Al Winters.**

Thomas J. Gamble retired on August 1 from his position as secretary of the Southern California Edison Co. He had been with the company for 37 years, serving as Secretary since 1949. **A. L. Chavannes,** assistant treasurer and manager of insurance for the firm, was elected to succeed Mr. Gamble.

Duro-Test Corp., North Bergen, N. J., has named **Leonard J. Campbell** as national accounts sales manager. Mr. Campbell has been associated with Duro-Test since 1936, serving as Metropolitan Division general sales manager for the past seven years.

Rudolph J. Takacs, formerly a lighting specialist with Cleveland Illuminating Co., has been named as sales representative for the Cleveland area by Virden Lighting Division, John C. Virden Co., Cleveland. In this position, Mr. Takacs will work with builders, electrical contractors and architects in addition to the Virden distributors in the northern Ohio area.

Ainsworth Lighting, Inc., Long Island City, N. Y., has named **Dudley F. Collier** as New England sales representative. Mr. Collier, formerly with Westinghouse Electric Supply Co., will make his headquarters in Boston.

Curtis-AllBrite Lighting, Inc., South San Francisco, Calif., has announced the promotion of **Robert H. Hirte** to general sales manager of the AllBrite division, with headquarters in South San Francisco. Mr. Hirte was formerly Los An-

(*Continued on page* 64A)

for tight spots in shallow ceilings

NEW GUTH shallow mounting

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... for shallow-plenum "problem" ceilings in corridors, halls, lobbies, under ducts, pipes—wherever construction limits depth above finished ceiling.

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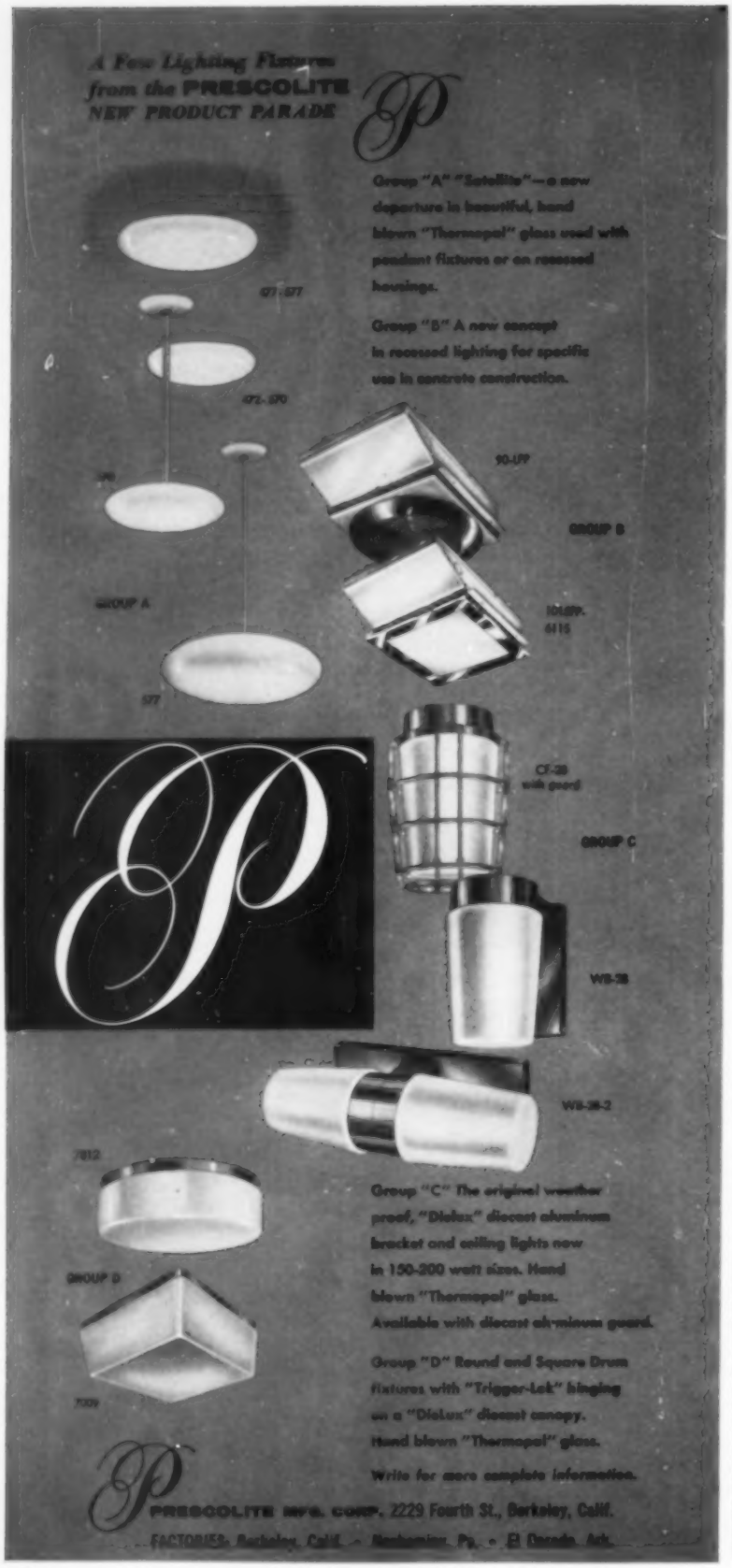
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GROUP D
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Write for more complete information.
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FACTORIES: Berkeley, Calif. - Manhattan Pl. - El Dorado, Ark.

(Continued from page 63A)

geles district manager for AllBrite. In the position of general sales manager, Mr. Hirte succeeds **Charles D. Buchanan,** President of the company, who formerly directed AllBrite sales and is now in charge of national sales.

Herbert P. Boyle has been signed as New England sales representative for Jefferson Electric Co., Bellwood, Ill. Mr. Boyle, who will have his headquarters in the company's Boston office, has spent the past 13 years in electrical product sales in New England and central New York state.

Kenneth D. Brumbaugh, formerly Sarasota County Building Director and Lighting Consultant for the National Advisory Committee for Aeronautics has announced the opening of consulting engineering offices at 3128 Southgate Circle, Sarasota, Fla. Mr. Brumbaugh is the newly-elected Chairman of the Florida Section of IES.

Moe Light Division of Thomas Industries, Inc., Louisville, Ky., has announced the appointment of **Jack Brown** as sales representative for the metropolitan New York area. As a certified lighting consultant, Mr. Brown will handle sales of residential, commercial and industrial lighting fixtures to electrical distributors in the area.

BOOKS AND PAMPHLETS

1959 Price List and Index of American Standards, available from the American Standards Association, Dept. PR66, 70 East 45th St., New York 17, N. Y. Free.

Publication lists the more than 1800 American Standards, and also recommendations published by the International Organization for Standardization and the International Electrotechnical Commission. These publications are also available from ASA.

American Standard Practices and Requirements for Pool-Cathode Mercury-Arc Power Converters, C34.1, published by the American Institute of Electrical Engineers, 33 West 39th St., New York, N. Y., $1.40 per copy.

This standard, which applies to all types of mercury-arc power converters employing rectifying devices with mercury pool cathodes and used for power conversion, was revised by the American

Institute of Electrical Engineers Industrial Power Rectifier Committee, H. Winograd, Chairman. It establishes usual and unusual service conditions, designates classifications for ratings, prescribes a basis for specification of performance characteristics and lists performance acceptance tests. Also included are Sections on rectifier transformers and definitions, including circuit nomenclature.

Standard C34.1 is available from either AIEE or the American Standards Association, Dept. PR 88, 70 East 45th St., New York 17, N. Y.

I Want To Know About the Electric Industry, published by Edison Electric Institute, 750 Third Ave., New York 17, N. Y.

The 1959 edition of this booklet, the eleventh in the series, presents the answers to 29 questions most frequently asked about the electric industry. It traces the growth and present status of the industry in such areas as production, expansion of facilities, construction expenditures, sales and uses in homes, industry and the atomic energy program. Included, in text and table form, are the latest available figures on the electric industry, as well as estimates of future growth.

Report on the Colors of Light Signals, published by International Commission on Illumination (CIE). Price: $2.00 per copy.

A brief history of the international standardization of colors of light signals, along with latest CIE recommendations for colors in three-, four- and five-color signal systems, is given in this report. Recommendations are given in the form of equations for boundaries of various colors and boundaries are also shown plotted on chromaticity diagrams. Equations and diagrams are both given in the CIE and RUCS coordinate system.

Also included are notes on the applications of the recommendations.

Orders for the booklet, accompanied by payment, should be sent to: L. E. Barbrow, Secretary, United States National committee CIE, National Bureau of Standards, Washington 25, D. C.

Current Projects of the American Standards Association, published by and available from American Standards Association, Dept. PR-94, 70 East 45th St., New York 17, N. Y. Prices: Members, 75 cents; non-members, $1.50.

Descriptions of 425 American Standard projects currently under study, including scope and sponsors of each project, are contained in this booklet.

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INDEX TO September

Abolite Lighting Division, Jones Metal Products Co.	14A
Adjustable Fixture Co.	65A
Advance Transformer Co.	Inside Front Cover
Alexander-Tagg Industries Inc.	67A
American Louver Co.	28A
Benjamin Electric Mfg. Co., Subsidiary of Thomas Industries Inc.	16A-17A
Century Lighting Inc.	67A
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Champion Lamp Works	61A
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Quadrangle Electric Co.	61A
Rambusch Decorating Co.	50A
Revere Electric Mfg. Co.	57A
Rotuba Extruders Inc.	51A
W. J. Ruscoe Co.	66A
Sheffield Plastics Inc.	62A
Sinko Manufacturing and Tool Co.	19A
Smithcraft Corp.	26A-27A
Sola Electric Co.	8A-9A
Sunbeam Lighting Co.	11A
Sylvania Electric Products Inc.	43A, 56A
Thompson Electric Co.	60A
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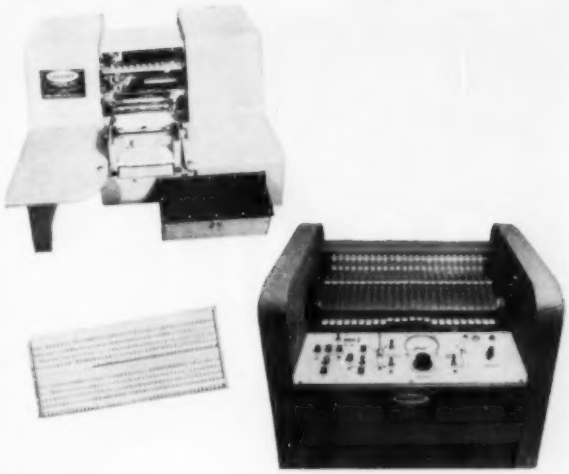

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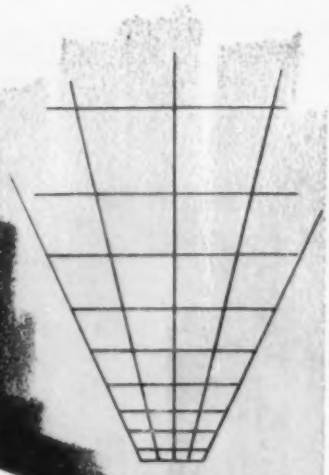
tension framed

CONTREX SOUNDSHEET



Soundsheet Translucent Acoustical Element, the only medium to successfully combine efficient acoustical and light diffusing properties, presents another "First" — drumhead-taut, flat Soundsheet available in 2' x 2' panels. Tension-framed Soundsheet offers a new freedom in the layout of overall lighting and acoustical ceilings. There's a new ease in maintenance, too. Simply dip-clean Soundsheet panels in a detergent solution. Tension-framed Soundsheet panels may be laid-in to standard "t" track suspension systems.

- COMBINES BALANCED SOUND ABSORPTION WITH EFFECTIVE LIGHT DIFFUSION!
- A UNIQUE LOW-COST CARBON STEEL TENSIONING DEVICE ELIMINATES COSTLY EDGE FRAMING, ASSURES PERMANENT TENSION — NO SAG OR BULGE!
- EASILY MAINTAINED — COMPLETELY WASHABLE — NO STATIC CHARGE TO ATTRACT DUST!
- BUILT-IN TENSION LOCK — BOWS CANNOT SLIP OUT OF POSITION!
- RICH TEXTURED APPEARANCE — NO SHADOWS!
- PLASTIC LAMINATE — U.L., FACTORY MUTUAL AND F.I.A. LISTED!

Write for Contrex's catalog, describing new applications for versatile Soundsheet. Contrex Company, Dept. CTF, Chelsea 50, Mass.

See our catalog in Sweet's Architectural File

CONTREX

Developed for Contrex by Bolt, Beranek and Newman, Inc.

Available from coast to coast through authorized manufacturers of lighting equipment.

HUGHEY and PHILLIPS, INC.

Specialists in Obstruction Lighting Equipment and Controls

- BEACON and OBSTRUCTION LIGHTS, designed to meet specifications of CAA, FCC, and Canadian DOT.

300MM Beacon — Single Obstruction Light — Double Obstruction Light

You'll find Hughey & Phillips have obstruction lights for every job. The engineering of each light offers maximum efficiency and simplified installation and maintenance. Whether you need bottom or side entrance conduit fitting types, there is a model to meet your requirements.

- SPECIAL CAST ALUMINUM WATERTIGHT JUNCTION BOXES, offering a wide choice in types of terminals, cable support, and factory installed screw cap receptacles.

Box with terminals, cable support, and receptacle in cover. — Box with factory installed screw cap receptacles. — Box with special terminals and cable support.

Hughey & Phillips have pioneered in the use of adequate junction boxes with proper terminals, and built-in cable support to meet NEC requirements.

- SPECIAL CONTROL UNITS, designed for both indoor and outdoor installation.

- Photo-Electric Control Units
- Beacon Flashers
- Combination Photo Control & Beacon Flashers
- Lamp Failure Indicator System
- Controls with Autotransformer system . . . pioneered by Hughey and Phillips for tall towers . . . increases lamp life.

Photo control, flasher and Lamp Failure Alarm

- TOWER LIGHTING ISOLATION TRANSFORMER

THREE SIZES . . . 750, 1750, 3500 WATTS

FEATURING:

- HIGHER EFFICIENCY
- IMPROVED REGULATION
- ADDITIONAL TAPS
- FIBER GLASS INSULATION
- EPOXY ENCASED
- VERSATILE MOUNTING

HUGHEY & PHILLIPS, INC.

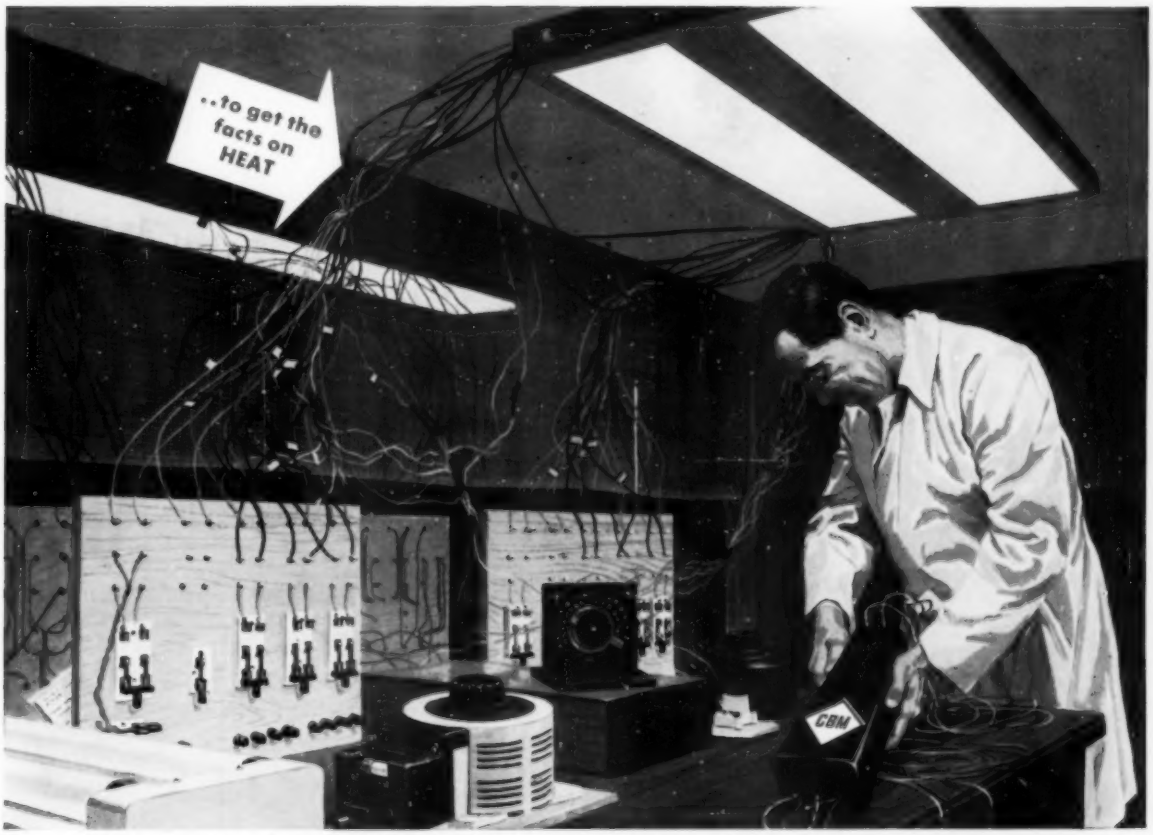
MANUFACTURERS OF

300MM Beacons, Obstruction Lights, Photo-Electric Controls, Beacon Flashers, Special Junction Boxes, Microwave Tower Light Control and alarm Systems, Tower Isolation Transformers, and Complete Kits for: Tower Lighting, Sleetmelter Power and Control.

3200 N. San Fernando Blvd. Burbank, Calif.

HOW CBM ASSURES YOU BETTER BALLAST VALUE

Heat measurement study under way at ETL for joint CBM-RLM-NEMA committee . . . aims to improve fixture and ballast heating conditions . . . assure better performance and service



This maze of wires above is needed to connect with thermocouples in fixtures, ballasts and other parts, so temperatures can be measured at different points. Screening shields break up drafts from air conditioning, help keep ambient constant.

NEW streamlined fluorescent fixtures, new high output lamps and space-saving mounting trends have often brought higher channel ambient temperatures . . . *and problems to user and installer!*

To deal with them, Certified Ballast Manufacturers led in setting up a joint technical committee with RLM and NEMA fixture makers. For this group, ETL is measuring temperature at 50 different points in representative fixtures, to try to pinpoint the part each of the lighted fixture components plays in the total temperature rise. Already progress has been made . . . and more is expected.

But this is just one contribution by CBM toward better ballast value. Behind it all is the CBM specification which assures quality performance, including:

Long lamp life • High power factor • Positive starting • Lasting service • Peak lighting performance . . . with conformance to spec checked and certified by ETL. Naturally, CBM Ballasts are UL listed!

Get the full story on why it pays to specify fluorescent fixtures equipped with ballasts that are Certified CBM. Write for: "To Insure Your Lighting Investment", Certified Ballast Manufacturers, 2112 Keith Building, Cleveland 15, Ohio.

CBM CERTIFIED by ETL

CERTIFIED BALLAST MANUFACTURERS

2112 KEITH BUILDING
CLEVELAND 15, OHIO

Participation in CBM is open to any manufacturer who wishes to qualify

4-59

THE V IS THE THING

25% UPLIGHT

BETTER LIGHTING QUALITY
BETTER WORKING ATMOSPHERE
10% BETTER MAINTENANCE

GUTH WYTELINER INDUSTRIALS

Their V-shaped center reflector can't trap dirt or dust. Therefore, it stays clean far longer than flat-center reflector units.

Guth 25% Uplight fixtures produce powerful downlighting and afford 27° normal shielding. They wash away gloom and overhead shadows, improve eye comfort and working conditions . . . assure maximum lighting efficiency, plus less maintenance, even under the poorest area conditions.

Units available for 430, 800 or 1500 M. A. operation.

RLM

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WITH BUILT-IN TRAFFIC LIGHTS

. . . red, green and yellow "signals" to direct traffic, protect workers, identify plant or storage areas.